

*Agricultural sciences**Article*

IMPROVEMENT OF TECHNOLOGICAL PROCESSES  
AND IMPROVING THE QUALITY OF TILLAGE IN SIBERIA

*Utenkov G.L., Dobrolyubov I.P.*

4

*Biological sciences**Article*

THE SUBCHRONIC TOXICITY OF DIFFERENT CONCENTRATIONS OF REACTIVE OXYGEN  
SPECIES AND BLOOD METABOLISM IN THE EXPERIMENT

*Soloveva A.G.*

8

*Chemical sciences**Article*

EVOLUTIONARY ROUTE IN THE SOLID STATE FORMATION  
OF BUILDING COMPOSITES

*Artamonova O.V.*

12

*Ecological technologies**Article*

GEOECOLOGY OF KAZAKHSTAN: ZONING, ENVIRONMENTAL STATUS AND MEASURES FOR  
ENVIRONMENT PROTECTION

*Bakytzhanova B.N., Kopylov I.S., Dal L.I., Satekov T.T.*

17

ANALYSIS OF ENVIRONMENTAL STATUS OF THE RIVERS AGHSTEV  
AND GETIK WITH ARMENIAN INDEX OF WATER QUALITY

*Simonyan A.G., Simonyan G.S., Pirumyan G.P.*

22

*Materials of Conferences*

THE INFLUENCE OF THERMAL POLLUTION ON HYDROBIOLOGY  
OF KAMA WATER BASIN

*Zinovev E.A., Kitaev A.B., Noskov V.M.*

28

*Medical sciences**Article*

BIBLIOMETRICAL ANALYSIS OF SAMPLING FRACTIONS  
OF THE NUMBER OF PUBLISHED WORKS WITH APPLICATION  
OF EMF, CARRIED OUT ON NEUROPHYSIOLOGICAL OBJECTS  
OF DIFFERENT KINDS

*Chizhenkova R.A.*

30

THE STATE OF VISUAL ANALYZER WHEN USING  
THE DRUG THIOGAMMA AT TYPE I DIABETES

*Frantseva A.P., Karpova E.N., Frantseva V.O., Chichanovskaya L.V.*

33

INGUINAL LYMPH NODES AFTER COMBINED OZONE-  
AND PHYTOTHERAPY AT THE LATE STAGE OF ONTOGENESIS

*Gorchakova O.V., Kutafeva N.V., Gorchakov V.N.*

36

CLINICAL NEUROLOGICAL CHARACTERISTIC OF PATIENTS  
WITH MULTIPLE SCLEROSIS IN VIEW OF THE SEVERITY CONDITION

*Pazhigova Z.B., Karpova E.N., Karpov A.S., Gandilan K.S.*

39

CHANGES HUMORAL IMMUNITY AND ANTIGENS HLA SYSTEM  
IN ACUTE PANCREATITIS

*Trukhan D.I.*

43

*Short Reports*

- COMPLEX CRYSTALLOGRAPHIC STUDY  
OF METABOLIC REHABILITATION EFFECT AT RECTAL USE OF REACTIVE OXYGEN SPECIES  
*Martusevich A.K., Razumovsky A.V., Peretyagin S.P., Kovaleva L.K., Luzan A.S.* 47
- SPECIALTIES OF CRYSTALLOGENIC PROPERTIES OF SALIVA AND BLOOD SERUM  
IN PATIENTS WITH THERMO-INHALATION TRAUMA  
*Martusevich A.K., Kovaleva L.K., Prudnikova Z.I.* 48

*Physical and Mathematical sciences  
Article*

- THE RATIONAL USE OF ENERGY RESOURCES FOR CREATION THE REQUIRED  
MICROCLIMATE PARAMETERS IN RUSSIAN ORTHODOX TEMPLES  
*Kochev A.G., Sokolov M.M., Kocheva E.A.* 51

*Technical sciences  
Article*

- A STUDY OF THE POWER CONTACTS IN MAGNETIC LIQUEFIED LAYER  
OF FERRO-IMPURITIES IN THE COOLANT IN THE WORKING VOLUME  
OF ELECTROMAGNETIC DENSITOMETERS (EPL)  
*Bezzubceva M.M., Volkov V.S.* 55
- METHOD OF ROUTING VARIABLE PITCH HELICAL SURFACE  
AND CONSTANT RADIUS PROFILE  
*Emelyanov D.V., Savin I.A.* 60
- METHODICAL AND TECHNOLOGICAL PECULIARITIES (FEATURES)  
OF 1C SOFTWARE PRODUCTS USING IN THE PREPARATION  
OF IT PROFESSIONALS AT THE UNIVERSITY  
*Eremina I.I.* 64
- THE DETERINATION AND APPROXIMATION OF THE FEASIBLE AND PARETO SETS  
*Matusov J.* 68
- DEVICES TO BEAT OUT THE FLAMES OF ROCKET PROPULSIVE JETS AT SPACESHIP STARTING  
*Zakhmatov V.D., Silnikov M.V., Chernyshov M.V.* 72

*Short Reports*

- SEPARATION OF BITUMEN FROM MINERAL PART OF OILBITUMENE ROCKS  
OF THE WESTERN KAZAKHSTAN  
*Turgumbayeva R.Kh., Abdikarimov M.N.* 80

*Economic sciences  
Article*

- ORGANIZATION OF EFFICIENT PROCUREMENT AT THE INDUSTRIAL HOLDING COMPANY JSC  
«ARCELORMITTAL TEMIRTAU»  
*Gelmanova Z.S.* 82
- A STATISTICAL APPROACH TO ANALYZING THE EFFICIENCY  
OF AGRICULTURAL PRODUCTION: THE EXAMPLE OF CENTRAL RUSSIA  
*Zavodskikh A.A., Chistyakova M.G., Shumetov V.G.* 88

*Pedagogical sciences  
Article*

- HEURISTIC APPROACH TO THE FORMATION OF THE STUDENTS' POLYCULTURAL  
PERSONALITY ON THE DISCIPLINE "RUSSIAN AS A FOREIGN LANGUAGE"  
*Bekman A.V.* 92

TRAINING OF SOCIAL WORK SPECIALISTS IN INSTITUTIONS OF HIGHER EDUCATION: PRACTICAL ASPECT <i>Degterev V.A.</i>	97
MANAGING EDUCATIONAL PROCESS WITH A FAMILY. PRE-SCHOOL EDUCATIONAL ESTABLISHMENT: MANAGEMENT OF EDUCATIONAL PROCESS <i>Ivanenko M.A.</i>	100
THEORETICAL BASIS FOR ADAPTIVE EDUCATION IN THE ZONE OF NEAREST DEVELOPMENT <i>Kaplunovich S.M., Kaplunovich I.Y.</i>	103
“GLOBAL SECURITY: A LOOK INTO THE FUTURE”: CONCEPT AND IMPLEMENTATION STRATEGY OF PROJECT <i>Korotun A.V., Larionova I.A.</i>	108
PODCASTING AS A TECHNICAL WAY OF INTERACTIVE COMMUNICATION OF XXI CENTURY <i>Nurekeshova G.R.</i>	112
DYNAMIC STUDY OF VOCABULARY OF THE RUSSIAN LANGUAGE: THE PROBLEM OF IDENTIFICATION AND CLASSIFICATION OF LEXICAL-SEMANTIC PARADIGMS <i>Pyataeva N.V.</i>	117
THE CONCEPT OF A NEW EDUCATIONAL-METHODICAL COMPLEX ON NATIONAL HISTORY: A NEW LOOK OR A RETURN TO TRADITION <i>Skripkin I.N.</i>	122
DYNAMICS OF THE DEVELOPMENT OF SOCIAL INTEREST IN CHILDREN WITH SPECIAL NEEDS RAISED IN INSTITUTIONS <i>Stoykova Zhaneta Dobрева, Katsarska Venetka Ivanova</i>	125
EDUCATION CLUSTER “COLLEGE- INSTITUTION OF HIGHER EDUCATION” AS A FACTOR IN ENSURING QUALITY CONTINUING PEDAGOGICAL PROFESSIONAL EDUCATION IN THE UDMURT REPUBLIC <i>Volkov P.B.</i>	130

*Culture and art*  
*Article*

SEMANTICS OF THE BASS REGISTER IN EUROPEAN MUSIC <i>Kazantseva L.</i>	133
--------------------------------------------------------------------------	-----

*Philological sciences*  
*Article*

SEMANTIC FOUNDATIONS OF TRANSPOSITION OF LANGUAGE UNITS FROM ADVERBS INTO PARENTHETIC-MODAL WORDS AND EXPRESSIONS <i>Shigurov V.V.</i>	136
-------------------------------------------------------------------------------------------------------------------------------------------	-----

*Psychological sciences*  
*Short Reports*

SOCIAL SAFETY OF THE PERSON AS A PSYCHOLOGICAL CATEGORY <i>Kislyakov P.A., Silaeva O.A.</i>	140
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## IMPROVEMENT OF TECHNOLOGICAL PROCESSES AND IMPROVING THE QUALITY OF TILLAGE IN SIBERIA

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Agricultural production and the industry is growing are you quite costly and produced cereal products are low competitive. The main component of the cost mechanism is the high energy consumption of running processes in the cultivation of crops. The reason for this is the use of outdated engine technology, based on the prevailing use of classic treatments of the soil. According to research by the FSBSI VIM only 10–15% of farms use innovative management techniques and resource saving technology. Forecasts of this institution show that during the next 15–20 years against the background of increasing energy consumption is not expected technological breakthroughs in the provision of alternative sources of energy. Consequently, the in implementation of technological processes in the agricultural enterprises will remain copper sky energy. The way technological development will depend on the choice of a particular base technology that becomes the basis for many subsequent improvements. Statistical indicator of the intensity of technological processes is the traction resistance of agricultural machinery related to the physical properties of the soil, its hardness. Investigated the continuous on-line condition monitoring of hardness (density) of the soil because of its moisture in the soil treatment. In determining soil moisture used its relationship with the thermal radiation of the soil in the surrounding area, which is measured pyroelectric infrared sensors.

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**Keywords:** technological process, treatment of soil, the hardness (density), moisture content, tillage machine, operational control, infrared sensors

The production of grain, a strategic product, remains dominated-conductive in the crop sector agricultural production, both Russia and Siberia. However, the implemented technologies have a high energy intensity and material intensity. In accordance with the principle of Bellman optimal trajectory of single components is also optimal. In [7] it is noted that in the cultivation of crops up to 40% of the resource capacity is consumed for the technological process of processing of the soil, and its share of, for example, in the wheat crop, for the conditions of Ural and Siberia is close to 20%. And more than 50% of mechanical work is performed with deviations from agronomic requirements. This is especially true of the main and additional processing of the soil, during which the deviation is increased to 200% [7]. According to the academician V.P. Yakushev, annual soil degradation in Russia reaches 450–500 thousand ha, due to the imperfection of the prevailing classical application of dump technologies. According to studies, I.I. Sventitskiy, the intensity of technical (anthropogenic) impacts on soil proportional to its saturation.

Analysis of tendencies of development of production in Russia shows that the rising cost of energy and material resources is outpacing the growth in number of end products – growth in productivity. The concept of increasing productivity in agro-industrial complex based on the use of intensive technologies with the use of powerful resource-technology in the modern conditions, have shown to be ineffective.

The modern state of agriculture in its strategic development focused on energy saving technologies based on minimization soil treatment up to zero, including No-Till technology. For conditions of Siberia, as follows from the above work, the abandonment of tillage leads to a reduction of 20–25% of the total cost of implementing the technology. It is noted that the use of No-Till does not always provide a high yield, however, an important ecological and economic benefits. It is believed that agricultural intensification is the only way to ensure the world's population with food. According to L.V. Pogorelyi, creation of flexible technological systems allows to increase productivity in 2 and more times.

**The aim of the study** is to improve the quality of soil treatment on the basis of increasing precision of operational control of its state.

The use of ecologically-oriented energy-saving automated technologies of cultivation and sowing of grain crops provides individual need of different type of soil in complex stress, restoring their fertility. Efficiency of the adaptive tillage Assembly (ATM), and hence yields, facilitates the continuous determination of density of soil directly when performing technological operations in machine-tractor unit. Because of the spots with a sharp change in the density of the soil the process of change in the traction resistance is random non-stationary. In [1, 2, 5, 9] analyzed model of the soil and generalized model that takes into account the diversity of soils and

their statistical characteristics, designed and tested in a production environment, the automatic control system as ATM, proven methods of operational control of the hardness (density) of the soil. It is shown that it is necessary to consider many factors that affect soil fertility, including its moisture content. However, the methods and technical means to ensure serving its records directly in the process of technological operations but rather studied and have no practical use. To address this shortcoming and dedicated to this work.

It is known that yield losses depend on the density (hardness) of the soil [3]:

$$P_U = k_n \rho_{md}^p$$

where  $\rho_{md}$  – average density of the soil.

Studies have found that between moisture and density (hardness) of soil there is a linear dependence with the increase of humidity decreases the hardness. For example, empirical relationships between the hardness  $y$  and humidity  $x$  black soil have the form [10]:

Background – couples plowing on the horizon 10...15 cm:

$$y = 2,792 - 0,042x; \quad v = 0,472. \quad (1)$$

Background – stubble on the horizon 10...15 cm:

$$y = 5,137 - 0,099 x; \quad v = 0,559,$$

where  $y$  is in MPa,  $x$  in percent;  $v$  – coefficient of variation.

Similar dependencies were obtained at depths 0...5 cm 5...10 cm (with different coefficients). Given the temperatures at which the hardness is particularly effective in the processing of the soil complex content (including sod-podzolic, sulfur-forest, etc.), which have a strong correlation between moisture content and hardness.

There is the ambiguity of determining the hardness of dry and wet soil. Possible but seasonal or short-term increase in soil moisture. Therefore, it may be, wrong decision about the impact on soil (including the payment of ameliorants or fertilizers), suggesting that its hardness does not require exposure, although humidity is declining, its hardness increases and can exceed permissible limits, this requires who to act on the soil to change its state.

Found that the traction resistance  $R_a$  ATM linearly related to the hardness (density) of the soil [4]:

$$R_a = F_k + abmT_{md}^p \quad (2)$$

where  $F_k$  is the force of rolling,  $a$  and  $b$  are plowing depth and width,  $m$  – empirical coef-

ficient:  $m = 0,014$  in the case of the working bodies without sticking;  $m = 0,030 \dots 0,032$  in case of sticking of the case of the working bodies of the soil;  $T_{md}$  – the average soil hardness in the depth of plowing.

In other cases [8] also use a linear relationship between the specific resistance of oriented soil  $k_a$  and its hardness  $T_{md}$ :

$$k_a = 5,4843T_{md} - 2,8153. \quad (2a)$$

Since the tractive resistance is evaluated on the working speed modes close to  $n = n_{nom}$  ( $n$  – frequency of crankshaft rotation), then from the equation of power balance

$$R_a \approx \beta(N_{ep} - N_{ex}), \quad (3)$$

where  $\beta$  – coefficient of proportionality, constant for a given traction vehicle and defined in the calibration by means of a traction dynamometer; the indices  $p$  and  $x$  correspond to the working (under load) and idle passages of the unit.

Using one or another indirect parameter  $P_{Np}$  reflecting the power of the engine it is possible to determine the traction resistance tillage units:

$$R_a \approx \beta(P_{Np} - P_{Nx}). \quad (4)$$

From equations (2)–(4) we get:

$$T_{md} = (\beta/abm)(N_{ep} - N_{ex}) = k_{cp}(P_{Np} - P_{Nx}), \quad (5)$$

where  $k_{cp} = (\beta/abm)$  – the coupling coefficient.

As a parameter  $P_N$  can be applied to the following quantities:

$$P_{N1} = |\bar{\epsilon}_\Sigma| = |\bar{\epsilon}_k| + |\bar{\epsilon}_g|; \quad P_{N2} = |\bar{\epsilon}_{\Sigma_{max}}|; \quad P_{N3} = |\bar{\epsilon}_{34}|;$$

$$P_{N4} = (\bar{\epsilon}_{34})_{max}; \quad P_{N5} = (\bar{\epsilon}_\Sigma^2)^{1/2}; \quad P_{N6} = (\bar{\epsilon}_{34}^2)^{1/2};$$

$$P_{N7} = p_k; \quad P_{N8} = \omega_T;$$

$$P_{N9} = p_{k\ input}; \quad P_{N10} = \Delta p_p;$$

$$P_{N11} = |\bar{p}_{k34}|; \quad P_{N12} = |\bar{p}_{k\ input34}|; \quad P_{N13} = |\overline{\Delta p}_{p34}|;$$

$$P_{N14} = |\bar{\epsilon}_{T34}|; \quad P_{N15} = |p_{k34_{max}}|;$$

$$P_{N16} = |p_{k\ input34_{max}}|; \quad P_{N17} = |\overline{\Delta p}_{p34_{max}}|;$$

$$P_{T18} = |\bar{\epsilon}_{T34_{max}}|; \quad P_{N19} = |\epsilon_{TDC}|; \quad P_{N20} = \Phi_{TDC};$$

$$P_{N21} = I_g; \quad P_{N22} = U_g^*,$$

where  $|\bar{\epsilon}_k|$ ,  $|\bar{\epsilon}_g|$ ,  $|\bar{\epsilon}_\Sigma|$ ,  $|\bar{\epsilon}_{34}|$  – average rectified value components of the angular acceleration

of the crankshaft: compressor, gas, thermodynamic, are multiples of 3...4 th harmonics of the rotation frequency of the crankshaft; in  $P_{N2} \dots P_{N6}$  applied the maximum and mean square values  $|\bar{\varepsilon}_\Sigma|, |\bar{\varepsilon}_{34}|, p_k$  – boost pressure;  $\omega_T$  and  $\varepsilon_T$  – angular velocity and acceleration of the turbocharger rotor;  $p_{k\text{input}}$  – air pressure upstream of the compressor;  $\Delta p_p$  – suction air at the compressor inlet; in  $P_{N11} \dots P_{N18}$  with index 34 – average rectified and index 34<sup>max</sup> – maximum values are  $p_k, p_{k\text{input}}, \Delta p_p, \varepsilon_T$  are multiples of 3...4 th harmonics of the rotation frequency of the crankshaft; in  $P_{N19} \dots P_{N20}$  applied offset the total acceleration of the crankshaft relatively instantaneous acceleration of the crankshaft when passing piston at TDC (the zero line)  $\varepsilon_{\text{TDC}}$ , which simultaneously leads to a shift by  $\varphi_{\text{TDC}}$  crank angle or time interval, corresponding to the angle between the TDC and the point of transition instantaneous acceleration through zero; in  $P_{N21} \dots P_{N22}$  used values  $I_g$  and  $I_{ng}$  or  $I_g = I_d^*$ ;  $U_g^* = U_g$  or  $U_g^* = U_d$  ( $I_{ng}$  and  $U_g$  – load voltage and DC current generators with parallel and independent excitation;  $I_d$  and  $U_d$  – rectified load current and voltage rectifier generator with independent excitation).

Established between soil moisture and thermal radiation (flux) of soil in the surrounding space there is a linear correlation. For example, in dynamic mode, when the evaporation of moisture from the soil:

$$m_c(dE/dt) = G_b = k_T Q_m, \quad (6)$$

where  $m_c$  is the mass of absolutely dry soil;  $E$  – liquid coefficient of the soil;  $G_b$  – the flow of evaporated water;  $Q_m$  – heat flow;  $k_T$  – coefficient of proportionality.

In static mode, the heat flow  $Q_m$  is associated with the moisture evaporating from the empirical relation:

$$Q_m = (597 + 0,45T_b)G_b, \quad (7)$$

where  $T_b$  is the temperature of the evaporated moisture;  $G_b$  – the flow of evaporated water, kg/h.

Therefore the measured thermal radiation of the soil to assess its moisture content and to determine the hardness of the soil based on its moisture content. To measure the thermal radiation of the soil can be used pyroelectric infrared sensors that convert the energy of the absorbed thermal radiation into an electrical signal (for example, Japanese sensor company IRA IRA-E410 QW1 angle 17° or IRA-E710 ST1 with a viewing angle of 45°). Depending on the width of the working bodies of tillage

mouth-line is selected from multiple pyroelectric infrared sensors to ensure the desired angle.

Previously for a specific type of ATM is measured by a tachometer frequency of rotation of the crankshaft of the internal combustion engine and the transmission of working set. When idle passage ATM alternately set and measured parameters  $P_{Nx}$ , reflection engine power and then on the same program at the same engine speed is similar to set and measure the parameters  $P_{Np}$ , reflected-of damaging the engine power at an operating passage ATM. Simultaneously, via the traction dynamometer measured tractive resistance. Determined in accordance with (4) the coefficients of proportionality  $\beta$  between the traction accompanied and the difference parameters  $P_{Np} - P_{Nx}$ . As a result of a series of measurements determined by the mean value of coefficients of  $\beta$ . Then, when the con-controlling the passage of this unit on a particular field, the extent of sticking the RA working bodies,  $m$  (2). With the help of the device coupling coefficient is introduced into the determinant of the hardness of the soil alternately the corresponding values of the coupling coefficient of the  $k_{cp}$  (5). With humidity setpoint coefficient and hardness of the soil is introduced manually into the soil moisture determinant factors known in advance, according to (6) and (7) based on soil temperature and soil hardness determinant based humidity – according to relations (1) and the like. Carry out basic treatment of soil on the working transmission. With the speed of the crankshaft sensor and tachometer control speed, which should be equal to that at which the determined coefficients  $\beta$  and  $k_{cp}$ .

Continuous operational control of soil condition in the course of its processing can improve flexibility, significantly increase the accuracy and reliability of the determined division-soil hardness because of its moisture, resolve the ambiguity in the definition of soil hardness and provide quality tillage soil tillage implements in use, motor-vehicle comprising an internal combustion engine. Roughly, in comparison with the known solution [6], the accuracy of determining the hardness of the soil is reduced by 10...20%.

### Insights

1. It is established that the production of grain products is expensive, due to high energy consumption. The static intensity of technological processes in machine technology is the tractive resistance of the prima taken of the agricultural, having a linear relationship with the rate of chopping of the soil.

2. The obtained expression, taking into account the relationship of the traction resistance of agricultural machinery with the main indicators of physical – mechanical soil properties – its hardness and humidity.

3. Proposed solution for an operational definition of indicators, taking into account the hardness of the soil moisture.

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## THE SUBCHRONIC TOXICITY OF DIFFERENT CONCENTRATIONS OF REACTIVE OXYGEN SPECIES AND BLOOD METABOLISM IN THE EXPERIMENT

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The study of the processes of free radical oxidation and energy metabolism of blood under the influence of different ozone concentrations during long use in the experiment have been conducted. Wistar rats were used in the work. Ozone were injected animals intraperitoneally daily for 30 days in the form of ozonated physiological solution with different doses of the drug in him – 0,6; 2,0 and 8 mcg. The intensity of lipid peroxidation, activity of superoxide dismutase, lactate dehydrogenase, the concentration of lactate and glucose was investigated in blood. General patterns of changes of blood biochemical parameters of rats show the toxic effects of ozone on the body with growth its concentration. The activity of superoxide dismutase increased when using only oxygenated physiological solution and O<sub>3</sub> at a concentration of 3000 mcg/l. The data obtained allow to conclude that optimal metabolic dose of ozone for the blood is 0,6 mcg.

**Keywords:** ozone, dose, lactate, glucose, lactate dehydrogenase, lipid peroxidation, blood

Ozone therapy is a new trend in modern medicine today [1–3]. The high redox potential of ozone is basis of its therapeutic action [4]. The use of oxidative therapies inextricably linked to the study of lipid peroxidation, as the change in the balance of pro – and antioxidant systems is one of the diagnostic criteria of severity of a pathological condition, describing the formation and progression of oxidative stress [2]. In addition, the use of ozone may be appropriate due to its multiple effects on metabolism [4]. Therefore, monitoring of free radical processes and the activity of oxidoreductase enzymes and their substrates in the blood allows you to monitor the effectiveness of ozone therapy, correcting the outcome of treatment [8]. However, the use of ozone is limited by the choice of doses. The use of this resource for the treatment and prevention of diseases is based on a wide range of therapeutic effects of different concentrations of ozone on the body. Oxygen radicals generated by the action of ozone, may have a positive effect and toxic effect on the cells and tissues of the body. To date, discussions have occurred, the subject of which is the question of “therapeutic” and “pernicious” effects of ozone on the body [10]. Given the known dose-dependent effect of ozone, it is necessary to assess the nature of the effects used in the clinic doses of ozone on the balance of pro – and antioxidant systems of the blood, the concentration of lactate and glucose in erythrocytes and plasma, as well as lactate dehydrogenase activity of erythrocytes. Taking into account this fact, this work is of practical and scientific interest. The aim of the study was to investigate the possible toxic effects of different con-

centrations of ozone on lipid peroxidation and energy metabolism in rat blood during prolonged use.

### Materials and methods of research

Experiments were conducted on 50 white rats of Wistar line with weighing 160–180 g contained on a standard diet of vivarium. The animals were divided into 5 groups of 10 animals in each: group 1 – control (intact healthy rats); group 2 – animals were injected 1 ml oxygenated physiological solution daily intraperitoneally; 3, 4, 5 groups of animals were daily intraperitoneally injected ozone in the amount of 1 ml for 30 days in the form of ozonated physiological solution with different ozone doses in him – 0,6; 2,0 and 8 mcg at saturating concentrations of ozone in the ozone-oxygen mixture 3000; 10000; 40000 mcg/l, respectively. After month the animals were scored by decapitation under combined anesthesia (Zoletil (60 mg/kg) + Ksila (6 mg/kg)).

Ozone was obtained from the oxygen produced by the oxygen concentrator, using the medical device of ozone therapy “Medozons Systems” The ozone concentration in the physiological solution was determined with help of ozone analyzer in liquid media “IKOZH-5”. In blood was investigated parameters of free radical oxidation (FRO), activity of superoxide dismutase and lactate dehydrogenase, the level of malonic dialdehyde, lactate and glucose.

The activity of the FRO processes were studied using the method of induced biochemiluminescence on the biochemiluminometer BCHL-06 (N. Novgorod). The following settings of biochemiluminogram were assessed:

tg 2 $\alpha$  – parameter of the rate of decrease of free radical oxidation processes in the plasma shows the total antioxidant activity (TAA);

S – light sum of chemiluminescence for 30 sec – reflects the potential possibility of a biological object to free radical oxidation.

The level of malonic dialdehyde (MDA) in plasma and hemolysate of erythrocytes (1:10) was estimated by the method of M. Uchiyama and M. Mihara [7]. The concentration of glucose and lactate in plasma and erythrocytes was measured on the analyzer «SUPER GL ambulance» (Germany).



Lactate dehydrogenase activity in the direct reaction (LDH<sub>dr</sub>) was evaluated in the hemolysate of erythrocytes (1:40) using lactic acid as the substrate, in the reverse reaction (LDH<sub>rr</sub>) – using pyruvic acid [6]. The activity of superoxide dismutase (SOD) was determined in the hemolysate of erythrocytes (1:10) on the inhibition of the formation of the product of adrenaline autooxidation [5]. The protein concentration was determined by Lowry's method in the modification [9]. Statistical analysis of the results of studies was performed using Statistica 6.0.

### Results of research and their discussion

During the studies the growth trend of free radical oxidation of blood plasma was noted when using oxygenated physiological solution and under the action of ozone at a concentration of 3000 mcg/l, the index *S* has increased by 7 and 12%, respectively, compared with healthy animals (Table. 1). The use of ozonized physiological solution with concentration of ozone 10000 and 40000 mcg/l was reduced lipid peroxidation in plasma of rats at 10 and 11%, respectively, compared to control animals. However in erythrocytes was a tendency to decrease free radical oxidation under the action of oxygenated physiological solution on

15%, at the concentration of 3000 mcg/l O<sub>3</sub> by 17%, the concentration of 10000 mcg/l O<sub>3</sub> – on 8% compared with healthy animals. When using an ozone concentration of 40000 mcg/l was marked the increase in lipid peroxidation in the erythrocytes of rats. Under the influence of oxygenated physiological solution and used ozone concentrations activation of total antioxidant activity of blood plasma was happened, the most marked when the ozone concentration was 3000 mcg/l: under the action of O<sub>3</sub> concentration of 3000 mcg/l TAA increased by 79%, in a concentration of 10000 mcg/l O<sub>3</sub> – 30%, at a concentration of 40000 mcg/l – 45%, when applying oxygenated physiological solution – on 59% compared with healthy rats. The increase of activity of antioxidant enzymes SOD under the action of ozone at a concentration of 3000 mcg/l at 34%, with a concentration of 10000 mcg/l is only 5%, when using oxygenated physiological solution by 57% and decrease of SOD activity at the concentration of ozone 40000 mcg/l at 45% compared with the control was revealed.

**Table 1**

Indicators of lipid peroxidation and antioxidant activity in the blood of rats under the influence of reactive oxygen species

The experimental conditions	S in plasma, notional units	tg 2α, notional units	S in erythrocytes, notional units	SOD, notional units/mg of protein
Control rats	10,55 ± 0,90	0,44 ± 0,03	8,05 ± 0,73	242,02 ± 22,01
O <sub>2</sub>	11,33 ± 1,02	0,70 ± 0,06*	6,86 ± 0,62	382,50 ± 32,21*
3000 mcg/l O <sub>3</sub>	10,87 ± 1,02	0,79 ± 0,06*	6,70 ± 0,58	323,70 ± 28,20*
10000 mcg/l O <sub>3</sub>	9,55 ± 0,86	0,57 ± 0,04*	7,44 ± 0,68	256,00 ± 23,21
40000 mcg/l O <sub>3</sub>	9,34 ± 0,84	0,64 ± 0,06*	8,41 ± 0,72	132,70 ± 12,11*

Note: \* – the differences are statistically significant compared to control rats ( $p < 0,05$ ).

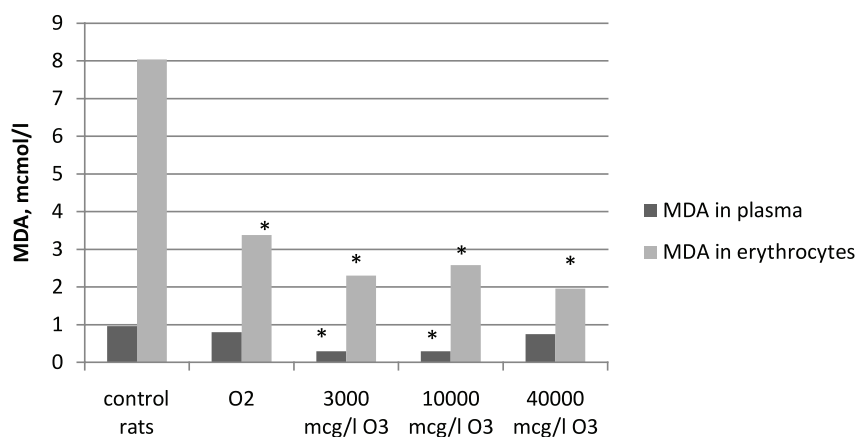


Fig. 1. The concentration of malonic dialdehyde (mcmol/l) under the influence of reactive oxygen species. Note: \* – the differences are statistically significant compared to control rats ( $p < 0,05$ )

Thus a reduction in the quantity of product of lipid peroxidation, malonic dialdehyde, was installed in plasma and erythrocytes under the influence of ozonized physiological solution. When using an ozone concentration of 3000 mcg/l, the concentration of MDA in plasma was reduced by 70%, in a concentration of 10000 mcg/l O<sub>3</sub> by 70%, at a concentration of 40000 mcg/l by 22%, when using oxygenated physiological solution by 17% compared with healthy rats. When use ozone concentration of 3000 mcg/l, the level of MDA in erythrocytes decreased by 72%, in a concentration of 10000 mcg/l O<sub>3</sub> – on 68%, in a concentration of 40000 mcg/l – on 76%, under the action of oxygenated physiological solution by 58% compared with healthy rats (Fig. 1).

Thus, in a wide range of ozone concentrations information about the dose-dependent nature [10] reaction of free radical oxidation for prolonged systemic use of ozone was confirmed. The regularity was confirmed not only on the basis of data of biochemiluminescence, but also study the quality of intermediate products of FRO, and SOD activity. In response to the introduction of O<sub>3</sub> the level of malonic dialdehyde decreases amid significant elevation of superoxide dismutase activity of erythrocytes. The total antioxidant capacity of plasma increases, probably due to the greater concentration of lipoproteins, ceruloplasmin, albumin, serotonin, insulin. Thus, the most pronounced changes in the system of pro- and antioxidant protection system of blood was noted when using ozone in a concentration of 3000 mcg/l.

The molecular mechanisms of action of various drugs and biologically active compounds depend on the peculiarities of the regulation of enzymes. There is no doubt that in this case LDH plays an important role in the regulation of energy metabolism of the cell [6]. In the direct reaction pyruvate is formed from lactate. Pyruvate can be used in the Krebs cycle under aerobic conditions. Return LDH reaction leads to the formation lactate from pyruvate and characterizes the severity of the anaerobic process in the cell. It is shown that under the action of ozone at a concentration of 3000 mcg/l LDH activity in the direct reaction increased by 66%, in a concentration of 10000 mcg/l O<sub>3</sub> – by 55%, at a concentration of 40000 mcg/l – by 78% compared with healthy animals (Fig. 2). The use of oxygenated physiological solution resulted in a decrease LDHdr by 22% compared with the control. The increased activity of the direct reaction of LDH is typical for aerobic conditions of the erythrocytes metabolism. Increased activity of LDH reduces of lactate and the accumulation of pyruvate. Therefore the activation intensity aerobic processes and the rate of metabolism in erythrocytes emanates under the O<sub>3</sub> influence. Lactate dehydrogenase activity in the reverse reaction was statistically significantly increased in ozone concentration of 3000 mcg/l to 58%, in a concentration of 10000 mcg/l O<sub>3</sub> – by 39%, at a concentration of 40000 mcg/l by 34% compared with control animals.

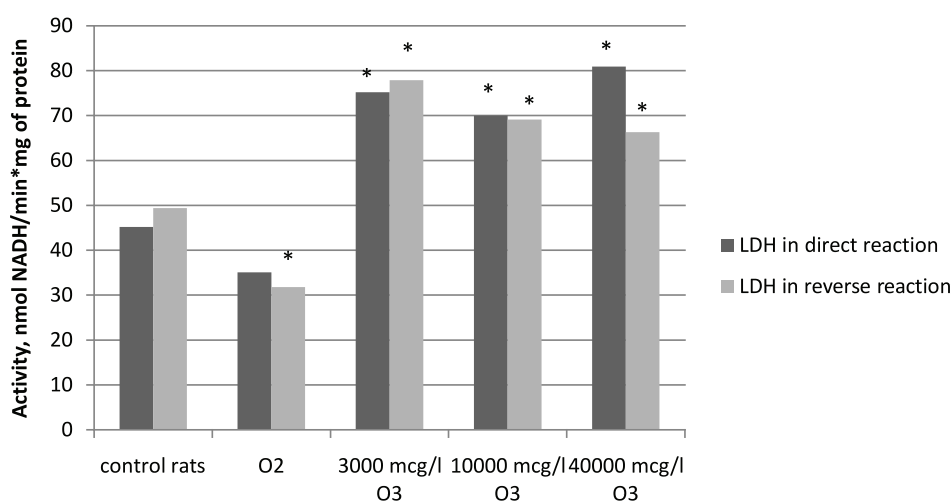


Fig. 2. The activity of lactate dehydrogenase (nmol NADH/min·mg of protein) under the influence of reactive oxygen species. Note: \* – the differences are statistically significant compared to control rats ( $p < 0,05$ )

Table 2

The level of glucose and lactate in the blood of rats under the influence of reactive oxygen species

The experimental conditions	Erythrocytes		Plasma	
	glucose, mmol/l	lactate, mmol/l	glucose, mmol/l	lactate, mmol/l
Control rats	1,26 ± 0,11	1,21 ± 0,11	9,24 ± 0,09	1,95 ± 0,16
O <sub>2</sub>	0,83 ± 0,07*	1,53 ± 0,14	7,90 ± 0,72*	2,65 ± 0,24*
3000 mcg/l O <sub>3</sub>	0,69 ± 0,06*	0,79 ± 0,07*	10,41 ± 0,94	2,94 ± 0,14*
10000 mcg/l O <sub>3</sub>	1,85 ± 0,16*	1,54 ± 0,14	17,62 ± 1,61*	2,72 ± 0,19*
40000 mcg/l O <sub>3</sub>	3,21 ± 0,30*	3,11 ± 0,29*	17,32 ± 1,57*	2,47 ± 0,22*

Note: \* – the differences are statistically significant compared to control rats ( $p < 0,05$ ).

The lactate level in erythrocytes was significantly decreased only when using an ozone concentration of 3000 mcg/l by 35%, under the action of ozone concentration of 10000 mcg/l and 40000 mcg/l, and oxygenated physiological solution concentration of lactate increased by 27%, 156 and 26%, respectively, compared with healthy animals (Table 2). In plasma it was revealed statistically significant increase of lactate by the action of ozone at a concentration of 3000 mg/l by 50%, concentration of 10000 mcg/l by 39%, in a concentration of 40000 mcg/l by 27%, when using oxygenated physiological solution – by 36% compared with the control. The level of glucose in the plasma under the action of ozone at a concentration of 3000 mcg/l did not differ from the level of the substrate control animals, at a 10000 mcg/l O<sub>3</sub> concentration of glucose in plasma was increased by 90%, at a 40000 mcg/l by 87% compared with control animals. When using an ozone concentration of 3000 mcg/l glucose levels in erythrocytes decreased by 45%, under the influence oxygenated physiological solution by 34% compared with control animals. The application of ozone concentration of 10000 and 40000 mcg/l resulted in increased levels of glucose in erythrocytes by 47 and 54%, respectively, compared with healthy rats. Thus, the ozone at a concentration of 3000 mcg/l affects on carbohydrate metabolism in the form of increased glycolysis, activation of glucose utilization, reduce the level of glucose in the blood. This is achieved through stimulation of the pentose phosphate shunt and aerobic glycolysis. The ozone concentrations 10000 and 40000 mcg/l resulted in an increase in the level of glucose in erythrocytes by 47 and 54% compared with the control.

### Conclusion

Summarizing, we can conclude that under the influence of ozone observed the processes of activation of glucose utilization, lactate, pyruvate, reactions of oxidative phosphorylation, increases resistance of erythrocyte membranes. It should be noted that the general regularities of changes of blood biochemical parameters in rats by intra-

peritoneal injection of ozone at different concentrations indicate the possibility of toxic effects of O<sub>3</sub> on the body along with the growth of its concentration. A dose-dependent effect of ozone on the metabolism of erythrocytes was revealed. The data obtained in the study of free radical oxidation and energy metabolism allows to draw the conclusion that the optimal metabolic ozone dose for blood is 0,6 mcg, in which there are positive changes in concentrations of glucose and lactate in the blood, the activity of lactate dehydrogenase in erythrocytes of animals, as well as the normalization of the balance of pro- and antioxidant systems in the plasma and erythrocytes.

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## EVOLUTIONARY ROUTE IN THE SOLID STATE FORMATION OF BUILDING COMPOSITES

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We consider the evolutionary route of formation of solid and justified “arsenal nano” modification of the structure of building composites. We discuss the concepts and foundations nanomodification of structures of inorganic building materials in the problems of the development of their advanced technology. It is shown that the disclosure of the evolution of the structure on the nanoscale level is determined by a complex management tools. They include mechanisms play an important role, using a predefined nano-sized additives of different nature.

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**Keywords:** system hardening, of building composites, nanomodification of structures

Building on the achievements of nano-chemistry, and referring colleagues have obtained results, it is important to discuss with the concept of common positions and strategies of technology nanomodification construction composites structures. At the same time, using the nanoeffects and nanoscale phenomena consideration is required to systematize the fundamental laws governing the formation and evolution of the solid through all of the original initial and intermediate stages of a substantial change in its status, spatial and geometric characteristics in a multi-level scale (from nano- to macro-) structure. And then highlight the key features and areas of research for the development of applied nanotechnology management techniques synthesis of matrix structures systems of composites and composite structures themselves.

If we talk about the technology of building materials and stages of transition in the processes of structure formation of the solid phase state, it must be borne in mind hydration (lime, gypsum, cement), hydrothermal – synthesis (silicate – autoclave ones) system hardening, thermal – synthesis (ceramics, glass) methods for producing composites [1].

When the detection and analysis of general evolutionary model of formation of solid substance can follow interpretations I.V. Melikhova [4].

In line with modern concepts applicable to systems of any structure in the formation of solid, the following main stages in the evolution of substance: the emergence phase, particle growth, agglomeration, spontaneous transformation in time (Figure).

We should talk about the three evolutionary transitions between stages and, accordingly, on the phenomena of molecular, topological and morphological criteria. In the evolution of the solid can be realized (Figure) the two branches

of the development process: the left, the corresponding small perturbations of the supersaturating, and the right, corresponding to large supersaturating of the phase-forming – guide macro component.

It is important to emphasize that each step corresponds to a specific range of the dimensions of the particles formed on it is solid. Shown in Figure dimensional scale illustrates the dimension geometric boundaries and limits. It is clear that the most significant “arsenal nano” we can use in the stages of nucleation and growth phase particles at other stages priorities are different physic- chemical methods of technology impact, affecting the micro and macro scale evolutionary process. The above should be considered in the development of methods of influence on each of the stages and transitions considered evolutionary route.

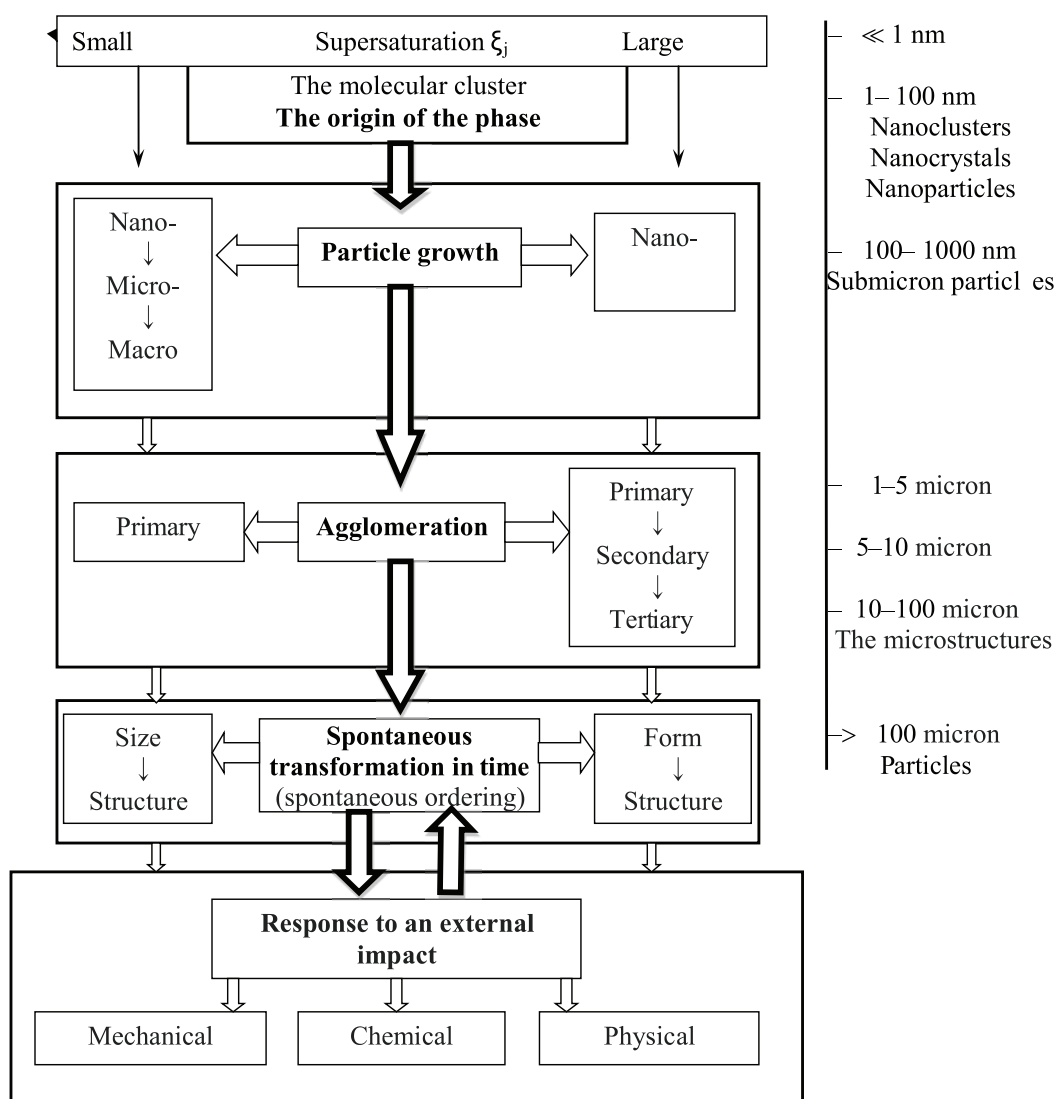
### Stage of the emergence phase

According to thermodynamic theory Gibbs – Volmer [8] of a new phase can for a certain critical degree of supersaturating, which depends on the natures of the raw materials and the presence of condensation nuclei which can be introduced into the system and the outside. Nucleation is possible at a certain (critical) the degrees of supersaturating of the solution that substance whose molecules are involved in the formation of a new phase. Given the rate of supersaturating  $g$  can express the critical nucleus size, and write it in the form of:

$$r = \frac{2\sigma V_m}{RT \ln \gamma} \quad (1)$$

Given this correlation equation of the total energy Gibbs nucleus of critical size will be:

$$\Delta G = \frac{16\pi\sigma^3 V_m^2}{3R^2 T^2 (\ln \gamma)^2} \quad (2)$$



The evolutionary path of formation of solid substances and "dimensional scale" of its structural components

From (2) we conclude that the Gibbs energy of formation of nuclei in homogeneous condensation is equal to one-third of its surface energy, and the remaining two-thirds of the energy is compensated with ethyl energetically favorable for the phase transition. From (2) it also follows that the energy of formation of the nucleus and the size of the critical nucleus depends on the degree of supersaturating of the system: the higher it is, the smaller the size of the resulting embryos are capable of further growth. Thus, bearing in mind the impact of technological capabilities, and in particular nanotechnology, on the generation stage of particles, above all, we should

speak about of such factors as the creation of supersaturating control and the introduction of outside nuclei (nuclei) condensation.

Supersaturating can be created in two ways: increasing the concentration of molecules in a medium material and (or) its reduced solubility. Under the first method in flow administered molecules of the substance or reagent streams that are formed this substance is discharged by solvent evaporation or freezing, etc. When implementing the second system is cooled or added substance – salting-out agents. Variants of these two methods (and corresponding technology), there are many [2, 3]. Deepening the analysis of the issue substantiate the "arsenal

of nano” should bear in mind the types of solid phase nucleation: nucleation in the gas phase, nucleic nucleation in a liquid medium, the nucleation on a solid surface, mechano-stimulated nucleation. Depending on the type of phase nucleation stage classification process can introduce solids synthesis methods, including in nanostate (Table 1).

the route of evolution solid “phase nucleation stage ® growth of particles”. Against the background of reducing the free energy of the system it is developing phenomenon of the molecular screening, in which embryos are clusters of molecules that contain only a little different in structure and size of the molecule. Fouling of the particle phase-forming substance

Table 1

The main technological methods of synthesis of solids and management factors depending on phase nucleation agents

Type inception phase of the substance / examples of systems	Technological methods of synthesis solid substance	Factors management
generation in the gaseous environment / nanosystems of metals and oxides metals	plasma chemical	<ul style="list-style-type: none"> <li>● changes in the ionization energy of condensed matter;</li> <li>● increase in the degree of ionization of condensed matter;</li> <li>● increase the rate of condensation</li> </ul>
	cryochemical	<ul style="list-style-type: none"> <li>● changes in the concentration of inert gases;</li> <li>● lowering the temperature of the deposition surface</li> </ul>
nucleation in liquid environment / hydration and hydrothermal synthesis system hardening (lime, gypsum, cement)	sol – gel	<ul style="list-style-type: none"> <li>● varying the chemical nature of the starting materials;</li> <li>● changes in the initial pH of the medium;</li> <li>● changes in the synthesis temperature;</li> <li>● change the duration of the synthesis</li> </ul>
	hydrothermal	<ul style="list-style-type: none"> <li>● varying the chemical nature of the starting materials;</li> <li>● changes in the synthesis temperature;</li> <li>● reduce the length of the synthesis;</li> <li>● increase the pressure in the system</li> </ul>
nucleation on surface solid / nanosystems of metals and their compounds	electrochemical	<ul style="list-style-type: none"> <li>● an increase in electrical potential;</li> <li>● varying the nature of the materials and the solvent;</li> <li>● changing the type and concentration of ions additives;</li> <li>● changes in the adhesive properties of the deposited particles;</li> <li>● changes in ambient temperature;</li> <li>● changes in the conditions of diffusion of matter</li> </ul>
mechano-stimulated initiation / thermal-synthesis system hardening (oxides, ceramics, glass)	mechanochemical	<ul style="list-style-type: none"> <li>● increase the energy of impact;</li> <li>● changes in the duration of exposure;</li> <li>● change in the position of the functional groups in the molecules of the crystal</li> </ul>
	ultrasonic	<ul style="list-style-type: none"> <li>● change the frequency of the ultrasonic pulse;</li> <li>● change the duration of the ultrasonic pulse;</li> <li>● changes in the phase state of the system</li> </ul>

### Stage of the particle growth

Each particle originated while in supersaturated environments, attaches itself to the molecules of the medium more often than they were breaking away from the particles [4]. If the medium contains a plurality of different molecules, then the particles in significant quantities fixed first molecules having close crystal- structure. In fact, on the surface of the growing particle is controlled by molecular selection.

In this way, i.e. in the form of molecular screening is implemented the first transition in

is facilitated if the space between the surface of the particles and clusters formed on it, there is a certain structural correspondence.

Form growing particles typically varies during the growth; the nature of changes of these depends on the structure and mechanisms of particle growth.

From the point of view of nanotechnology, it is possible and it is necessary to bear in mind the problem of changes of the concentration of crystallization conditions and the use of additives substances, in particular, nano-additives

possessing similar to the nuclei of the crystal phase structure, and providing targeted acceleration of particle growth phase-forming substances [6], and their morphological modification.

According to V.B. Ratinova additives are divided into four classes:

1 – additives that alter the solubility of the system hardening and entering it into chemical interaction

2 – additives that react with the curing to form insoluble compounds or malodissot-siruyuschih;

3 – additives, nucleating;

4 – additives, adsorbed on the grains of the solid [7].

Due to the marked our three global transitions in the evolution of the classification solid additives useful to clarify and separate the oversized on the basis of nano-sized, ultra-fine and micro particulates (Table 2). Based on theoretical considerations, it is

believed that nanoscale additives and ultra 1–3 classes can actively participate in the processes of nucleation stage and grade 4 in the growth of the particles.

In general, the structure- modifying effect of participation and nanoscale modifiers may be the result of inter-related mechanisms. It should be emphasized that the incorporation of additives in curable system (most efficient in this case will be additive nanoparticles) may facilitate the formation of nuclei, as DG can thus reduce in accordance with equation (2).

### Stage of agglomeration

In the course of evolution in the hardening system accumulate aggregates of particles of different size that are placed relative to each other in a certain order, resulting in aggregates become like colloidal crystals. The process can take place in several stages, forming the primary, secondary and tertiary aggregates

**Table 2**

Modifiers nano-, ultra-, micro-sized level of dispersion and their mechanism of action

Number	Type systems	The name and the chemical composition	Particle size and morphology	The mechanism of action
1	The nanosized	Nano-sized silica $\text{SiO}_2 \cdot n\text{H}_2\text{O}$	$\varnothing = 5\text{--}10$ nm spherical particles	1) Direct chemical involvement of nanoparticles (NP) in heterogeneous processes of phase formation of hydrated compounds; 2) the catalytic role NP as nucleation (growth of a new phase)
2		Sol $\text{Fe}(\text{OH})_3$	$\varnothing = 5\text{--}10$ nm, spherical particles	
3		Sol $\text{Al}(\text{OH})_3$	$\varnothing = 30\text{--}50$ nm, spherical particles	
4		Montmorillonite – a synthetic $(\text{Na}, \text{Ca})_{0.3}(\text{Al}, \text{Mg})_2\text{Si}_4\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$	$\sim 5\text{--}10$ nm hexagonal plates	
5		Chrysotile nanotubes $[\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4]$	$\varnothing = 25\text{--}50$ nm, $l = 100\text{--}700$ nm a tubular structure	
6		Carbon nanotubes fulleroids type carbon content $\sim 99\%$	$\varnothing = 2$ nm; $l = 200$ nm tubes of graphite cloth	Increased packing density of particulate addition, changing the porosity of the material structure
7		The zeolite sol – type zeolite NaX, ratio $\text{Si}/\text{Al} = 1,3 \dots 1,5$	$\varnothing = 0,8\text{--}1,2$ nm reticular structure	
8	Ultra dispersed	“Astralen – S” water-soluble fullerene analogue carbon content $\sim 99\%$	the average cluster size 300 nm a tubular structure	1) Increasing the packing density of the addition of dispersed particles; 2) zoning structure
9		Micro silica $\text{SiO}_2 \cdot n\text{H}_2\text{O}$	$\sim 100\text{--}300$ nm	
10	Micro dispersed	Montmorillonite – natural $(\text{Na}, \text{Ca})_{0.3}(\text{Al}, \text{Mg})_2\text{Si}_4\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$	$< 1$ micron layered, leaf structure	Zoning structure hardening
11		Shungit – C 60–70%; ash 30–40%; $\text{SiO}_2$ – 35–50%; $\text{Al}_2\text{O}_3$ – 10–25%	0,1–10 micron graphite-like globules	
12		Bergmeal – $\text{SiO}_2$ – 70–85%; $\text{Al}_2\text{O}_3$ – 5–13%; $\text{Fe}_2\text{O}_3$ – 2–5% и др.	0,01–0,001 mm spherical rounded opaline globules of silica	

to form complex hierarchies. After accumulating a sufficient number of particles of the system when the probability of meeting and fusion of the particles becomes commensurate with the probability of their molecular growth, the process of agglomeration. There comes a second evolutionary transition “growth @ agglomeration of particles”. This phenomenon is the main selection topological ranked units consisting in the fact that the medium destroys and eliminates disordered aggregates and promotes ranked forms consisting of particles with similar morphologic parameters.

In real materials technology agglomeration step may be controlled by additives and surface-active agents (surfactants) are widely used plasticizers and superplasticizers (SP).

In this regard, it seems to us important structural systematics mechanisms modifying effect of plasticizers and superplasticizers agglomeration step in the evolutionary route of solid formation [1]. It should further be noted that the use of plasticizing additives action is often important and necessary condition furthermore the possibility of introducing the nano- and ultrafine particles in hardening since in normal conditions, these particles are chemically active and prone to spontaneous agglomeration prevents uniform volume of distribution in the material obtained. Same class of surfactant additives can solve this rather complex task nanotechnology.

#### Stage of spontaneous pattern formation

Evolutionary change a hardening system objectively linked to the third evolutionary transition “agglomeration radio @ spontaneous pattern formation”. In the late stage of growth and agglomeration step system state far from equilibrium, so a certain period within the system simultaneously develop the redistribution of matter and energy, which leads to spontaneous ordering system. There is a phenomenon of morphological selection and there is a “change in the geometry of the system”, ordered aggregates formed a certain shape and size of the place of less ordered forms. Processes leading to the approximation of the size and shape of the particles to equilibrium, and called morphological selection. Streamlining processes

occur by two mechanisms: recrystallization and solid phase [5].

From a technological point of view of the stage management of spontaneous pattern formation can be based on the temperature and high-temperature treatment, the use of different types of compaction force pressing for the introduction of particulate additives, etc. As a result, nano-modification on the stage of spontaneous pattern formation can form ordered structures hardening close-packed crystals, increase the area of intergranular contacts in malignancy. This is achieved by varying the morphology of the resulting systems, which also determines the type of contact that occurs (private crystal – contact contiguity, fiber-needle – contact fusion, plate-and-prism – contact germination) can also be spontaneously dispersed reinforcement structure itself.

#### Conclusion

Thus, evidence-based principles of management structure at the nano – level is a key factor in the development of high-tech composites modified construction of a new generation. Possible “nanotools” to create high-quality building composites quite a lot, the approaches are very diverse and they can count on effective innovative technological solutions that are useful for a wide range of building materials.

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## GEOECOLOGY OF KAZAKHSTAN: ZONING, ENVIRONMENTAL STATUS AND MEASURES FOR ENVIRONMENT PROTECTION

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Geoecological zoning of the Republic of Kazakhstan is given. 20 geo-ecological regions are highlighted, including the region 3 with the catastrophic level of environmental destabilization of the natural environment. The main factors of formation of geoecological conditions are natural (geological, climatic, hydrological) and technogenic (especially – industrial, oil, mining) factors. Environmental condition is characterized. Conservation of nature is justified. Considered the regions ecological risk of geosystems of Kazakhstan allow to identify the most important scientific and practical tasks in the field of optimization of natural environment specific natural-anthropogenic geosystems.

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**Keywords:** geoecology, zoning, environmental risk, environment protection, Kazakhstan

The environmental situation is becoming more and more important development affecting all spheres of political and economic prosperity of the state. In the third Millennium the world is changing at an increasingly rapid pace, and the joint action of States to protect the environment often lag behind economic and social change. Gradually, the economy of the countries-members of CIS penetrate the environmental standards of developed countries.

### General characteristics of the territory

The area of Kazakhstan is 2 724 900 km<sup>2</sup>. The length from West to East is about 3000 km from the Caspian sea and lower reaches of the Volga to the Altai mountains and China, from North to South and 1700 km from the southern part of the West Siberian plain and the spurs of the Ural mountains to the Tien Shan and the Kyzyl Kum desert. The territory of Kazakhstan lies in the Central and southern latitudes of the temperate zone as far South it comes in a strip, crossing to the subtropics. The total length of the borders of the Republic is 12187 km, including: with the Russian Federation – 6467 km, Uzbekistan – 2300 km, with China – 1460 km, Kyrgyz Republic – 980 km, Turkmenistan – 380 km, on the Caspian sea – 600 km.

### Geoecological zoning of the Republic of Kazakhstan

Geoecological zoning of the Republic of Kazakhstan allows to identify regions of the risk of danger of ecological destabilization of the environment, under the environmental risk should understand the likelihood of adverse consequences of any environmental resources (deliberate or accidental, gradual and catastrophic) of anthropogenic changes and factors. Identify areas of environmental risk classification is based on the signs of the degree of environmental stress environment.

Natural geological factors: tectonic faults, neotectonic movements, seismic and geodynamic activity play a large importance for geoecological assessment. Principles and methodology of an integrated geoecological estimation are universal, are applied in regions with the various natural and technogenic conditions, have great value for the environmental management [4–16]. On the territory of Kazakhstan are the following provinces geo-environmental catastrophic and critical levels of interference with the ecological state of the environment [1–3].

### The areas with the catastrophic level of ecological destabilization of the environment

#### 1. The waters and dried bottom of the Aral Sea (North Aral province).

*The environmental condition.* The death of the Aral Sea ecosystem. In 1990, the almost complete cessation of the inflow of river water, lowering of the reservoir 16 m, reducing the water surface area with 66,000 to 26,700 km<sup>2</sup>, increasing the salinity of water from 10 to 46 g/dm<sup>3</sup>. The formation of a dried out bottom of sea salt desert dust-salt storms take out more than 1 million tons of salt per year. Excess indicators for all components of the environment; pollution of air, water and soil, destruction of biota. Mass human infection due to poor quality of drinking water or lack of it.

*Measures for the protection of nature.* Restoration of the Aral Sea as geosystems in the previous (1960) settings can not be, because it is the environmental changes become irreversible. This planetary ecological disaster. The solution is only possible on the basis of the International Programme for Saving the Aral Sea. It should be a comprehensive scientific study of the natural and built environment of the entire basin Syr Darya, Amu Darya and the Aral

Sea region. The main objective – to stabilize at the present level of the Aral Sea, the division of the waters with the help of cutting the dams on the target reservoirs. Possible transfer of sea water from the Caspian Sea via water pipeline pumping stations; interbasin transfer of the runoff; interbasin transfer of the Ob river runoff in the Central Asian region on the basis of governmental agreements. Priority actions: strict regulation standards of water use and irrigation land drainage water and the increase in releases of river water into the Aral Sea. Social protection of the population of the Aral Sea region, artificial irrigation, desalination of saline water, and others.

### 2. The territory of the former Semipalatinsk nuclear test site (Chingiztauskaya province).

*The environmental condition.* On the territory of the Semipalatinsk nuclear test site from 1949 to 1991. produced 470 nuclear explosions (in 1963 – only underground). The area of the landfill about 9000 km<sup>2</sup>. However, radioactive pollution of the natural environment covered a much greater territory of neighboring regions of Kazakhstan and Russia. Directly in the area of the landfill: the removal of land from agricultural use for decades. The most dangerous radioactive isotopes: strontium-90, cesium-137. For more information on the range in the press are not available.

*Measures for the protection of nature.* Addressing ecological disaster – on the basis of the law of the Republic of Kazakhstan “On social protection of citizens suffered from nuclear tests at the Semipalatinsk nuclear test site” (of 18.12.1992). A comprehensive study of the effects of nuclear testing on the basis of the International Programme. Restoration of natural geosystems through land reclamation. Socio-economic and legal benefits to the population affected by the test. Mass health examinations and treatment for people living near the site. Careful monitoring of the use of any types of natural resources from the zone of ecological disaster.

### 3. Industrial area of Rudny Altai (West Altai mountain province).

*The environmental condition.* The powerful concentration of giant enterprises of non-ferrous metallurgy in agglomeration years. Ust-Kamenogorsk, Zyrjanovsk, Ridder and adjacent mines. Adverse climatic conditions, ground-level temperature inversions, calm, fog exacerbate pollution. Air pollution, water and soil emissions of lead, zinc, copper, mercury, arsenic, cadmium and others. There are about 100 contaminants, including the most dangerous to human health heavy metals (immune,

hematopoietic, cardiovascular system). Accumulated 1 billion. Tons of man-made waste. Accumulation of heavy metals (lead, cadmium) in agricultural production.

*Measures for the protection of nature.* The zone of ecological disaster on the territory of the East Kazakhstan region. The reduction of power and a reshaping of the enterprises of nonferrous metallurgy, equipment for their advanced treatment facilities, introduction of wasteless technologies. Strict control over the observance of ecological standards of environment quality. Reconstruction and relocation of industrial enterprises, improvement of technological processes in ferrous metallurgy and mining industry. The adoption of the State program on improvement of ecological situation in the Ore Altai. Widespread mass medical examination of the population. Given the unfavorable natural-climatic conditions of the region possible closure or conversion of industrial enterprises.

### **Regions with a critical level of ecological destabilization of the environment [2]**

#### 4. Eastern Aral Sea region (Lower Syrdarya province).

*The environmental condition.* Air pollution as a result of the removal of pylesolevogo basin of the Aral Sea. Uncontrolled pollution p. Syrdarya industrial and domestic waste, chemical fertilizers and pesticides. Repeated excess of MPC in the water content of chlorides, sulfates, nitrates, nitrites. Undrinkable water causes gastrointestinal disease.

*Measures for the protection of nature.* Restoring normal levels of cleanliness of air and water resources by improving production technology, waste water treatment. Ensuring effective measures to protect water resources of the entire river basin river Syrdarya based Interstate Program (IFAS).

#### 5. Shymkent industrial hub (Syr Darya province).

*The environmental condition.* Very strong air pollution in industrial emissions of lead, zinc, nitrogen, hydrocarbons, silicon dust, asbestos and others. In the soil – arsenic, lead, cadmium, pollution river Badam.

*Measures for the protection of nature.* Wasteless tehnolo-giya equipment companies perfect treatment facilities. Partial re-industrial enterprises, removing some of them outside the city limits. Ozelenenie industrial and residential areas, strict control of the environment,

#### 6. Balkhash industrial hub (North Balkhash province).

*The environmental condition.* Air pollution Balkhash combine “Kazakhmys”. Dominated

gas emissions of lead, molybdenum, copper and sulfur. Dumps and wastewater pollute the lake. Balkhash (copper, lead, zinc, arsenic, fluoride, sulfates, chlorides, etc.). Huge piles Kounrad mine (pit depth – 400 m). Air pollution from the mine dust.

*Measures for the protection of nature.* Further improvement of waste-free production technology, proven in the Balkhash TPK: utilization of sulfur dioxide, flotation leaching of copper, the use of slag and strains in the construction industry, and others. Non-release of industrial effluents into the lake Balkhash. Landscaping, recultivation of mining waste dumps and sludge.

#### 7. Temirtauskiy industrial hub (Yereimantau-Bayanaul province).

*The environmental condition.* Air pollution from industrial gases of ferrous metallurgy (industrial complex “Ispat-karmet”), the chemical industry: dust, nitrogen oxides, sulfur, and others. It is heavily contaminated river. Nura wastewater plant of synthetic rubber: soderzhanie mercury in water 2–8, soil 8 times higher than the MPC.

*Measures for the protection of nature.* The introduction of non-waste production of advanced technology, with the capture of waste gases of metallurgical and chemical production. Improved sewage treatment plants, water recycling. Pollution prevention river Nura and Sarkand reservoir. Plantations and protective green areas. In the long term – resettlement outside the industrial zone.

#### 8. Karaganda industrial region (Ermentau-Bayanaul province).

*The environmental condition.* Air pollution by dust, ash of the coal industry. Man-caused land subsidence as a result of the construction of mines, cuts. Waste heaps of rock – the sources of dust pollution of soil and water resources. Violation of groundwater aquifers during the extraction of coal.

*Measures for the protection of nature.* Disposal of waste from coal mining and coal washing in the construction and road industry. Land reclamation, waste heaps, dumps, with the possible waste rock backfill waste pits, mass planting to reduce the dust content of the air basin. The transfer of the residential areas of hazardous areas, are over exhaust shafts in safe areas.

#### 9. Zhezkazgan industrial hub (Sarysu-Kyzylzhar province).

*The environmental condition.* Development of polymetallic ores (Satpayev). Combine “Kazakhmys”: concentrating mill, smelter, Zhezdinsky manganese mines. Air pollution

by dust, the flue gases (oxides of sulfur, nitrogen). Large areas of dumps. Water pollution Kengir reservoir.

*Measures for the protection of nature.* Environmental stabilizatsiya environment through waste-free and low-waste technology. Innovative and effective treatment facilities. Revegetation. The solution of acute problems of water supply and water supply on the basis of construction of water main Irtysh – Karaganda – Zhezkaz Gan. A harmonious blend of nature and architectural ensembles. Greening, industrial and residential zoning.

#### 10. Almaty industrial district (Zailiyskay mountain province).

*The environmental condition.* The main pollutant Almaty air are vehicles, power plants, boilers (sulfur oxides, carbon, nitrogen, dust). Strong zagryaznenie industrial and municipal runoff of mountain rivers and soils. The sharp decline in reserves and production rate of artesian water. Environmental pollution favor the mountain-valley terrain, ground-level temperature inversions, frequent calms. Underestimation of the direction of mountain-valley winds in the modern building.

*Measures for the protection of nature.* Environmental stabilization on the basis of the State Program «On urgent measures for the development of the city of Almaty». The introduction of sewage treatment plants and waste-free technology in industrial predpriyatiyah. Prevention of emissions from motor vehicles, by reducing the number of cars in the city with 250 thousand. Units to a minimum. Wide transition to electric transportation a passenger. The development of the underground. Gasification of heating systems of private residential sector. Partial changes in city planning by restoring the “corridors” in residential areas for the penetration of free mountain-valley winds in areas of urban sprawl. Mass planting, reconstruction of irrigation ditch network. Hard, continuous monitoring of environmental conditions.

#### 11. Karatau-Taraz industrial district (Karatau mountain province).

*The environmental condition.* Strong air pollution, surface water and soil chemical industry (superphosphate production). Among the industrial emissions of the most toxic compounds of fluorine, phosphorus, dust.

*Measures for the protection of nature.* Reducing gas emissions from the production of phosphate fertilizers. The introduction of non-waste production technologies to capture waste gases. Preventing the spread of toxic substances in the soil. water and food chains – in the human body. The introduction of automation

control state of the environment from an operational system of alerting the population. Redesigning enterprises in the city, in part – the closure or transfer outside the urban area.

12. Kustanai-Rudny Industrial District (Pritobolskaya province).

*The environmental condition.* Air pollution by dust enterprises iron ore basin, the construction industry and transport. Huge areas of disturbed land, deep pits (Sokolovsky – design depth of over 460 m. Sarbaisky – 630 m). Huge mining dumps near the town of Rudny. Pollution p. Tobol industrial effluents.

*Measures for the protection of nature.* Land reclamation: the alignment of dumps, seeding grass, plantations use waste rock as ballast material in the construction industry. Preventing waste rock storage on the arable soils. Protection of Tobol and reservoirs on the river.

13. Ekibastuz industrial hub (Priirtyshskaya province).

*The environmental condition.* Huge brown coal sections: career, waste rock dumps define «industrial landscape», a very strong dust air and soil. Powerful power: CHP-1 and CHP-2 emit large amounts of ash, dust, sulfur oxides and so forth. Ash emissions can be traced for hundreds of kilometers from the town of Ekibastuz.

*Measures for the protection of nature.* Revegetation. Plantations, phytomelioration. Improving the technology of high-lignite combustion in power. Use of waste rock for road construction and building industry.

14. Nord-Ppukaspiysky (Tengiz industrial district (Caspian province).

*The environmental condition.* Deep-lying oil reservoirs (5 km). Emissions from the depths of associated gas (hydrogen sulphide, methane) during exploratory drilling (MPC excess of 7–10 times) and industrial oil. Soil erosion in the areas of production due to the indiscriminate laying of roads, “drawing” of drilling rigs. The coastal strip is at risk of flooding under the influence of the transgression of the Caspian Sea.

*Measures for the protection of nature.* Improving the technology of oil and natural gas. Preventing catastrophic emissions of associated gas located in the bowels of the earth under enormous pressure, and ignition. Improving technology Buzachi oil field, has a high content of asphalt substances and vanadium. Land reclamation, revegetation and soil. Non-random paving dirt roads, in order to prevent soil erosion.

15. Mangistau industrial hub (Mangistau province).

*The environmental condition.* The imperfection of technology of oil production, gas flaring

results in air pollution. Soil erosion near the oilfields. Oil spills negatively affect the condition of water resources, soil and vegetation.

*Measures for the protection of nature.* Improving the technology of mining and processing Mangyshlak oil differs a high content of paraffin fractions and increased viscosity. Preventing the flaring of associated gas. Land reclamation and soil disturbed during oil production.

16. The Baikonur Cosmodrome (Lower Syrdarya province).

*The environmental condition.* Periodic launches of carrier rockets break the plasma structure of the ionosphere and affect the ecology of geosystems. Falling to Earth spent stages of rockets from unburnt residues are very toxic fuel – heptyl result in highly contaminated soil, destruction of animals that eat contaminated plants. Flushing toxins into local waterways is extremely dangerous for human health.

*Measures for the protection of nature.* Development of programs of ecological restoration of lands disturbed as a result of military and space tests. Careful consideration and mapping of areas falling space objects, constant monitoring of the environmental impact areas. Collection and disposal stages and parts of rockets. Land reclamation: where necessary the mechanical removal of soil contaminated with heptyl. Restoration of the productivity rangelands. Clinical examination of the population, animals, control over the quality of agricultural products.

17. Kazakhstan part of the Syrdarya river basin (Syr Darya and the Lower Syr-Darya province).

*The environmental condition.* The Syr Darya River is heavily polluted by industrial, household and agricultural waste water from the territory of Kazakhstan and Uzbekistan. The main pollutants: chlorides, sulfates, nitrates, pesticides, and others. The content of nitrates in the lower reaches of greater than 45 times the MPC. The water contains pathogens. Water pollution is exacerbated by the constant reduction in rate of flow, making it difficult to self-purification processes.

*Measures for the protection of nature.* Need Interstate Environment Programme water resources of the river. Syrdarya. Compliance with technological conditions and standards that ensure environmental cleanliness of water resources of the entire river basin. Syrdarya. Monitoring the use of pesticides in agricultural fields and mineral fertilizers, preventing dumping into the river drainage water. Creating vegetative barriers along the river (afforestation),

capable of absorbing chemical ingredients zagryazne-niya aquatic environment. Restoring tugai (riparian forests).

#### 18. The lower reaches of the valley of the river Shu (Moyinkum province).

*The environmental condition.* As a result of intensive water use in the upper reaches of the river Shu in the lower reaches of a sharp decline in rate of flow, drying up of the river. Pollution reaches river Shu due to washout from agricultural fields of fertilizers, pesticides, water accumulation industrial emissions Zhambyl TPK.

*Measures for the protection of nature.* Regulation of water use on the basis of an interstate agreement between Kazakhstan and Kyrgyzstan. Control of runoff from irrigated land.

#### 19. The Kazakhstan part of the Irtysh basin (West Altai Mountain province).

*The environmental condition.* Severe contamination of the river Irtysh within the Rudny Altai the industrial and domestic sewage. Ust-Kamenogorsk, Ridder, Zyryanovsk, village Deep, etc. handed down by the rivers Bukhtarma, Ulba Krasnoyarka etc. the Main pollutants: cadmium, copper, zinc and other heavy metals, petroleum products.

*Measures for the protection of nature.* Prevention of pollution of the river by powerful mining industry, ferrous metallurgy, power industry. Environmental risk factors is carried out in China damming runoff. Black Irtysh, which will cause a decrease runoff. Irtysh at least 20% and dramatically exacerbate water problems in Central Kazakhstan.

#### 20. Sorbulak lake drive wastewater Almaty (Ili province).

*The environmental condition.* Wastewater storage Almaty is located in the natural relief depression near the river. Kaskelen. Artificial pond overflowing sewage and is in critical condition. The volume of waste water is close to the limit marks (800 000 000 m<sup>3</sup>). Perhaps a repeat of the catastrophic break the earthen dam, which caused human casualties, pollution Kapshagai reservoir.

*Measures for the protection of nature.* Strengthening wastewater storage dam. Mass planting fast-growing poplar trees to enhance the transpiration of water and strengthen the banks. Widespread use of water for watering of irrigated lands in view of the prevention of pollution by toxic agricultural products.

In the provinces, as the geo-ecological systems are interconnected natural ingredients creates an opportunity to foresee and avoid or eliminate the adverse environmental impact of human activities [3]. This opens up the possibility of using these geo-environmental rec-

ommendations to support both current and future activities in the field of nature protection, allows to calculate the economic effect of environmental work, opens prospects for conservation and transformation of the nature of Kazakhstan.

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## ANALYSIS OF ENVIRONMENTAL STATUS OF THE RIVERS AGHSTEV AND GETIK WITH ARMENIAN INDEX OF WATER QUALITY

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The water quality of rivers Aghstev and Getik was evaluated by Armenian Water Quality Index at first time. It was shown that from the source to the mouth of the river is observed to increase the value of the Armenian index that indicates a decline in the water quality of the rivers from the 1st to the 2nd class of pollution. It is shown that the cause of pollution is the high content nitrogen compounds and metals. It was established that the Armenian index of water quality has a linear relationship with the water pollution index and unit-combinatorial index of water quality and has an inverse relationship with the Canadian Water Quality Index.

**Keywords:** rivers Aghstev and Getik water quality index, Armenian Water Quality Index, entropy, geocological syntropy

The study of ecological status of Republic Armenia Rivers is importance both for evaluation of water quality of that objects and for their further rational use. Development of water quality assessment methods using conventional indicators comprehensively taking into account various properties of surface water is an important issue. The complex evaluation is an extremely difficult task that requires a simultaneous consideration of a variety of properties of the water object. For evaluation of water contamination degree the comprehensive indicators are used which take possible to evaluate the contamina-

tion of water at the same time on a wide range of quality indicators. Water Contamination Index (WCI), Canadian Water Quality Index (CWQI) and Specific-combinatorial Water Quality Index (SCWQI) are used for evaluation surface water quality in Republic of Armenia [3, 4, 7]. It must be noted that most developed complex characteristics of water object in one way or another connected with the existing maximum permissible concentration (MPC). In the last years we suggest Entropic Water Quality Index (EWQI) and Armenian Water Quality Index (AWQI) for evaluation surface water quality [8, 9].



Monitoring Positions cross-sections of the River Aghstev

The aim of presented paper is evaluation of River Aghstev and it's tributary Getik by Armenian Water Quality Index.

**River Aghstev** is right tributary of the Kura. Aghstev is 133 kilometres long with a drainage basin of 2,589 square kilometres [5]. It rises in the territory of Armenia, on the northwest slope of Mount Tezler. The following takes place in a wider valley. The largest tributaries – Bldan, Voskepar, Getik. Two monitoring posts located on the river Aghstev: number 15–1,2 km above the city of Dilijan, number 16–0,5 km below the city of Dilijan, number 17–1,0 km above the city of Ijevan, number 18–8 km below the city of Ijevan Getik River – right tributary Aghstev. The river is 63 km [5]. On Getik river located positions: number 19–0,5 km above the city of Chambarak and number 20 – at the mouth of the river.

#### Determination procedure

In hydroecological systems there can be processes both with increase, and with entropy reduction. The concept of entropy has many interpretations in various fields of human knowledge. The system interacts with the outside world as a whole. An open system can exchange energy, material and, which is not less important, information with environment. The system must it must consume information from the environment and provide information environment for act and interact with environment. Shannon was the first who related concepts of entropy and information [6]. He was suggesting that entropy is the amount of information attributable to one basic message source, generating statistically independent reports. Get any amount of information entropy is equal to the lost. Information entropy for independent random event  $x$  with  $N$  possible states is calculated by the equation:

$$H = -\sum_{i=1}^N p_i \log_2 p_i,$$

where  $P_i$  – probability of frequency of occurrence of an event.

Entropy general equation of Shannon was been used at the first time by Mac-Artur in 1955 for evaluation of degree of structuring biogenesis [1]. In 1957, R. Margalef postulated theoretical concept that meets a variety of entropy for a random selection of species from the community [2]. As a result of these works widespread and universal recognition received index Shannon  $H$ , sometimes referred to as a Shannon information index of diversity [6]:

$$H = -\sum n_i / N \log_2 \left( \frac{n_i}{N} \right).$$

Pollution of water systems can be represented as a system of the hydro-chemical parameters (elements), the concentration of which exceeds the MPC. Then in the equation Shannon pi- probability of the number of cases of MPC excess of  $i$ -substance or water indicator of total cases of MPC –  $N$ ,  $P_i = n_i/N$ .

$$H = \log_2 N - \sum n \log_2 n/N;$$

$$H = \log_2 N - I;$$

$$I = \sum n \log_2 n / N,$$

where  $I$  – geocological syntropy [10].

The following computational algorithm is used for determination  $I$ ,  $H$ ,  $EWQI$  and  $AWQI$  values:

1. Determines the number of cases of MPC excess of  $i$ -substance or indicator of water –  $n$ .

2. Estimates the total amount of cases the maximum permissible concentration ( $N$ ) –  $N = \sum n$ .

3. Computes  $\log_2 N$ ,  $n \log_2 n$  and  $\sum n \log_2 n$ .

4. Determines geocological syntropy ( $I$ ) and entropy ( $H$ ):

$$I = \sum n \log_2 n / N \quad \text{and} \quad H = \log_2 N - I.$$

5. Then  $EWQI$  is determined:  $G = H/I$ .

6. Further, the total amount multiplicity MAC exceedances is estimated ( $M$ ) –  $M = \sum m$ .

7. Computes  $\log_2 M$ .

8. Armenian Water Quality Index was obtained:  $AWQI = G + 0,1 \cdot \log_2 M$ .

#### Results of research and their discussion

It was established that the water of the Rivers Agstev and Getik regularly exceeded the value of  $BOD_5$  and concentrations of nitrite and ammonium ions, due to water pollution by domestic wastewater. It was shown that water of Rivers Agstev and Getik is also contaminated by some metals. Thus, in the river water is regularly increased MPC of copper, vanadium, aluminum, cobalt, manganese and selenium (Tables 1–4). For example, in 2012 year in the position № 16 of River Agstev  $BOD_5$ ,  $NH_4^+$ ,  $NO_2^-$ , V, Cu, Al and Mn number of MPC increasing cases is 4, 5, 6, 11, 11, 9 and 7 times, respectively. The amount of excess cases of MPC –  $N = 53$ ,  $\sum n \log_2 n = 159,309$ ;  $I = 159,309/53 = 3,005$ ;  $H = \log_2 53 - 3,005 = 2,72$ ,  $G = 2,72/3,005 = 0,900$ . The total amount of the multiplicity of MPC exceedances –  $M = \sum m = 13,2$ ;  $\log_2 M = 3,7$ ;  $A = 0,90 + 0,37 = 1,270$  (Table 3)

**Table 1**

Entropic and Armenian Water Quality Indexes for River Aghstev and Getik (2009)

Positions	15		16		17		18		19		20	
Indicator	$n$	$n \log_2 n$	$n$	$n \log_2 n$	$n$	$n \log_2 n$	$n$	$n \log_2 n$	$n$	$n \log_2 n$	$n$	$n \log_2 n$
$\text{NH}_4^+$	0	0	6	15,5	0	0	0	0	7	19,64	0	0
Cu	7	19,64	12	43	11	38,0	12	43,0	5	11,6	11	38,0
V	8	24	10	33,2	10	33,2	10	33,2	11	38,0	8	24
Al	12	43,0	12	43	12	43,0	12	43,0	11	38,0	11	38,0
Mn	0	0	5	11,6	9	28,5	6	15,5	4	8	0	0
$N$	27		45		42		40		38		30	
$\sum n \log_2 n$	86,64		146,3		142,7		134,7		115,24		100	
$I$	3,201		3,251		3,398		3,367		3,032		3,333	
$H$	1,551		2,238		2,00		1,95		2,213		1,571	
$G$	0,4845		0,688		0,5886		0,5796		0,7300		0,471	
$M = \sum m$	10,9		17,4		18		19		20,2		16,1	
$\log_2 M$	3,44		4,12		4,167		4,254		4,333		4,006	
AWQI	0,8285		1,109		1,0053		1,005		1,161		0,871	

**Table 2**

Entropic and Armenian Water Quality Indexes for River Aghstev and Getik (2010)

Positions	15		16		17		18		19		20	
Indicator	$n$	$n \log_2 n$	$n$	$n \log_2 n$	$n$	$n \log_2 n$	$n$	$n \log_2 n$	$n$	$n \log_2 n$	$n$	$n \log_2 n$
$\text{NH}_4^+$	0	0	4	8	0	0	0	0	4	8	0	0
$\text{NO}_2^-$	0	0	5	11,6	0	0	0	0	3	4,75	0	0
Cu	6	15,5	10	33,2	10	33,2	10	33,2	6	15,5	11	38,0
V	9	28,5	12	43	10	33,2	11	38,0	9	28,5	11	38,0
Al	10	33,2	8	24	9	28,5	10	33,2	8	24	11	38,0
Mn	0	0	5	11,6	7	19,64	0	0	4	8	0	0
Se	3	4,75	4	8	4	8	3	4,75	0	0	3	4,75
$N$	28		48		40		34		34		36	
$\sum n \log_2 n$	81,96		139,17		122,547		109,18		88,75		118,75	
$I$	2,927		2,903		3,063		3,211		2,610		3,300	
$H$	1,877		2,678		2,555		1,873		2,474		1,867	
$G$	0,641		0,922		0,736		0,583		0,948		0,566	
$M = \sum m$	15,6		21,8		15,9		18,5		22		17,2	
$\log_2 M$	3,96		4,44		3,98		4,200		4,46		4,10	
AWQI	1,037		1,366		1,134		1,003		1,394		0,979	



**Table 3**

Entropic and Armenian Water Quality Indexes for River Aghstev and Getik (2011)

Positions	15		16		17		18		19		20	
Indicator	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$
BOD <sub>5</sub>	0	0	4	8	6	15,5	0	0	0	0	8	24
NH <sub>4</sub> <sup>+</sup>	0	0	5	11,6	0	0	0	0	0	0	0	0
NO <sub>2</sub> <sup>-</sup>	0	0	6	15,5	0	0	5	11,6	0	0	0	0
Cu	0	0	11	38,0	9	28,5	10	33,2	0	0	10	33,2
V	10	33,2	11	38,0	10	33,2	11	38,0	7	19,64	0	0
Al	10	33,2	9	28,5	9	28,5	9	28,5	7	19,64	12	43,0
Mn	6	15,5	7	19,64	9	28,5	0	0	0	0	0	0
<i>N</i>	26		53		43		35		14		30	
$\sum n\log_2 n$	81,9		159,309		134,236		111,344		39,28		100,18	
<i>I</i>	3,15		3,005		3,121		3,181		2,80		3,339	
<i>H</i>	1,547		2,72		2,302		1,945		1,005		1,565	
<i>G</i>	0,491		0,900		0,737		0,611		0,358		0,468	
$M = \sum m$	6,9		13,2		10,7		10,2		4,4		10	
$\log_2 M$	2,78		3,7		3,4		3,34		2,14		3,32	
AWQI	0,769		1,270		1,077		0,945		0,572		0,800	

**Table 4**

Entropic and Armenian Water Quality Indexes for River Aghstev and Getik (2012)

Positions	15		16		17		18		19		20	
Indicator	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$	<i>n</i>	$n\log_2 n$
BOD <sub>5</sub>	0	0	0	0	10	33,2	8	24	0	0	0	0
NH <sub>4</sub> <sup>+</sup>	0	0	9	28,5	0	0	7	19,64	0	0	0	0
NO <sub>2</sub> <sup>-</sup>	0	0	8	24	5	11,6	9	28,5	0	0	0	0
Cu	12	43,0	12	43	11	38,0	11	38,0	7	19,64	12	43
V	10	33,2	10	33,2	10	33,2	10	33,2	8	24	10	33,2
Al	11	38,0	10	33,2	10	33,2	10	33,2	8	24	10	33,2
Mn	8	24	8	24	10	33,2	8	24	4	8	0	0
Cr	0	0	4	8	6	15,5	6	15,5	5	11,6	5	11,6
Se	2	2	2	2	2	2	3	4,75	0	0	0	0
<i>N</i>	43		63		64		72		32		37	
$\sum n\log_2 n$	140,2		195,9		199,90		220,79		87,24		121,0	
<i>I</i>	3,256		3,109		3,123		3,066		2,726		3,270	
<i>H</i>	2,167		2,864		2,873		3,100		2,274		1,936	
<i>G</i>	0,666		0,921		0,919		1,011		0,834		0,592	
$M = \sum m$	13,5		21		17,6		19,7		27,3		14,6	
$\log_2 M$	3,752		4,390		4,135		4,298		4,768		3,865	
AWQI	1,041		1,351		1,3325		1,4408		1,311		0,9785	

Table 5

Entropic and Armenian Water Quality Indexes for Rivers Aghstev and Getic (2009-2012)

Positions	2009		2010		2011		2012	
	EWQI	AWQI	EWQI	AWQI	EWQI	AWQI	EWQI	AWQI
15	0,485	0,828	0,641	1,037	0,491	0,769	0,666	1,041
16	0,688	1,109	0,922	1,366	0,900	1,270	0,921	1,351
17	0,588	1,005	0,736	1,134	0,737	1,077	0,919	1,3325
18	0,580	1,006	0,583	1,003	0,611	0,945	1,011	1,4408
19	0,733	1,161	0,948	1,394	0,358	0,572	0,834	1,311
20	0,476	0,871	0,565	0,979	0,468	0,800	0,592	0,9787

$$AWQI = (0,271 \pm 0,065) + (1,227 \pm 0,108) \cdot EWQI; \quad R = 0,98481; \quad N = 6 \text{ (2009 year);}$$

$$AWQI = (0,351 \pm 0,033) + (1,094 \pm 0,044) \cdot EWQI; \quad R = 0,99676; \quad N = 6 \text{ (2009 year);}$$

$$AWQI = (0,172 \pm 0,049) + (1,235 \pm 0,079) \cdot EWQI; \quad R = 0,99191; \quad N = 6 \text{ (2009 year);}$$

$$AWQI = (0,309 \pm 0,075) + (1,133 \pm 0,090) \cdot EWQI; \quad R = 0,98765; \quad N = 6 \text{ (2009 year)/}$$

Analysis of obtained data indicate that AWQI has liner dependence with EWQI (Table 5).

The obtained data indicate that along the source to the mouth of the river water quality decreases. After the cities of Dilijan and Ijevan

AWQI increases, this indicates a decline in water quality of River Voghji caused by water pollution by domestic wastewater.

Quality of Rivers Aghstev and Getik water also comprehensively evaluate by other indexes: WCI, EWQI, CWQI, SCWQI (Table 6).

Table 6

Water Quality Indexes for Rivers Aghstev and Getik (2009)

Index	AWQI	EWQI	WCI	CWQI	SCWQI
15	0,828	0,485	0,97	81,61	1,56
16	1,109	0,688	1,59	73,13	2,33
17	1,005	0,588	1,42	74,17	2,06
18	1,006	0,580	1,46	72,23	2,40
19	1,161	0,733	1,5	71,52	2,11
20	0,871	0,476	1,4	72,15	1,95

Analysis of obtained data indicate that AWQI has liner dependence with WCI, SCWQI, EWQI and an inverse dependence with CWQI:

$$AWQI = (0,338 \pm 0,257) + (0,474 \pm 0,183) \cdot WCI; \quad R = 0,79116; \quad N = 6;$$

$$AWQI = (0,358 \pm 0,313) + (0,309 \pm 0,150) \cdot SCWQI; \quad R = 0,71722; \quad N = 6;$$

$$AWQI = (0,271 \pm 0,065) + (1,227 \pm 0,108) \cdot EWQI; \quad R = 0,98481; \quad N = 6;$$

$$AWQI = (2,631 \pm 0,977) - (0,022 \pm 0,013) \cdot CWQI; \quad R = 0,64206; \quad N = 6.$$

For river Aghstev excellent correlation,

$$AWQI = (0,408 \pm 0,074) + (0,426 \pm 0,053) \cdot WCI; \quad R = 0,98468; \quad N = 4;$$

$$AWQI = (0,417 \pm 0,207) + (0,273 \pm 0,098) \cdot SCWQI; \quad R = 0,89146; \quad N = 4;$$

$$AWQI = (0,181 \pm 0,119) + (1,377 \pm 0,203) \cdot EWQI; \quad R = 0,97886; \quad N = 4;$$

$$AWQI = (2,823 \pm 0,642) - (0,024 \pm 0,009) \cdot CWQI; \quad R = 0,89661; \quad N = 4.$$

### Conclusion

Thus, for the first time using *AWQI* the quality of Rivers Aghstev and Getic water evaluate. It was shown that from the source to the mouth of the river there is an increase in the value of the *AWQI*, which indicates the decline in the quality of water of the rivers from the first to the second class of pollution. After the cities Dilijan and Ijevan of *AWQI* increases, indicating a decrease in water quality due to pollution of water River Aghstev by domestic wastewaters. It was established the correlation between *AWQI* and other water quality indexes.

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*Materials of Conferences***THE INFLUENCE OF THERMAL POLLUTION ON HYDROBIOLOGY OF KAMA WATER BASIN**

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The temperature factor for the aquatic ecosystem is one of the most important among the abiotic components that affect the structure of the aquatic fauna as plankton, so benthos and fish fauna. Thus, any deviation from the natural rhythm of seasonal temperature dynamics, especially in the direction of increasing its level, is classified as thermal pollution. Observations made at the place of discharge of warm water, as well as above and below it, have shown that in the warm water discharge area, there is no tendency for decrease or increase in biomass. There have been some discrepancies between the seasons: the highest biomass has been found in the overheating water zone in months of minimum water temperature; then the differences have smoothed out in the warmer months. Therefore, the carried out observation has shown no significant thermal effects on the ground biocenoses in the area suffering from thermal pollution. The increased temperature background can be dangerous in terms of changing the dates of appearance and the number of generations of aquatic animals such as plankton, benthos, and fish. Besides, effects on the genetic structure of the populations are possible. There is controversy regarding when in conditions of high temperature may some positive effect be achieved (due to acceleration of maturity, changes in growing season, increase in the rate of growth). However, in an atypical thermal regime, rhythmic of physiological processes are destabilized, including those associated with reproduction, and the normal course of morphogenesis is also disturbed. The intense rhythm accelerates the mutation processes and leads to the increase in generic variation. Finally, this could lead to a reduction in genetic potential and a decrease in the evolutionary flexibility of the species. Water temperature, which is outside the natural background, can be a powerful destabilizing factor, which may have a decisive impact on populations of fish and other aquatic organisms, transforming their genetic structure. This may have implications not only for the particular species, but also for the ichthyofauna and the entire ecosystem of a reservoir. Thus, thermal pollution, being the consequence of heated water dumping by thermal and nuclear power plants, is the most important anthropogenic factor influencing the thermal regime of reservoir refrigerants and their ecological sys-

tems, and creating conditions for the emergence of environmental risks.

The decrease of dissolved oxygen in a thermal influenced zone has been observed during the whole navigation period when the Perm State District Thermoelectric Power Station has been constructed.

According to the sanitary standards of the Russian Federation the content of the dissolved oxygen in a sample should not be lower than 4 mg/dm<sup>3</sup> during the whole year round. The oxygen content in water during the navigation period in the case study area equals to the 2<sup>nd</sup> class of quality (clean). In winter season the oxygen content changes from 8,9 up to 12,7 mg/dm<sup>3</sup> and waters also belong to the 2<sup>nd</sup> class of quality (clean). According to biological oxygen consumption (BOC<sub>5</sub>) (in winter this index changes from 0,54 up to 0,65 mg/dm<sup>3</sup>) waters correspond to the 1<sup>st</sup> class of quality (pure). Thus, warm water discharge by the Perm State District Thermoelectric Power Station actually has not influenced the class of water quality according to oxygen and biological oxygen consumption.

The conducted field works have revealed the possibility to use quantitative correlation of saprophylic bacteria of mesophilic group (with 20°C temperature optimum) with thermophile bacteria quantity (with 30°C temperature optimum).

The quantity of both saprophylic bacteria extracted from water varied widely from June till October. It achieved its maximum in summer (13,5/11,0 thousand cells per ml.), and its minimum in autumn (0,01/0,02 thousand cells per ml.). The near-bottom samples were characterised by a larger quantity of bacteria [2].

The quantity of heterotrophic bacteria in a thermal influenced zone is approximately in 2–3 times higher in comparison to reference areas (in the area of an old river-bed). The maximum quantity of heterotrophic bacteria has been observed in the zone of strong heating. The quantity of saprophylic bacteria decreased significantly when heated water mixed with non-heated one. This tendency has been observed during the whole period of study.

The amount of thermophile saprophyte bacteria exceeded the mesophile bacteria quantity in the zone with strong thermal pollution. The extraction of mesophile bacteria from the biocenosis is the evidence of the strong effect of a thermal factor on the bacteria community formation.

The decrease of water temperature in autumn leads to the decline of the total amount of saprophytic bacteria in the case study area as well as across the water body. The thermophile forms of saprophylic bacteria have been distinguished

in autumn. Their largest amount (0,30 thousand cells per ml.) has been discovered in the zone affected by thermal pollution. This amount is mostly remarkable in summer water samples collected at the surface of water body. It is approximately in ten times exceeds the bacteria amount at the river-bed reference area.

To determine the thermal pollution extent during the day sampling from three horizons has been done at the station located at the edge of thermal pollution zone. The soil has been taken twice during the day. The significant changes in the bacteria amount in water samples every four hours have not been observed. The quantity of mesophilic bacteria fluctuated slightly from 0,48 up to 1,06 thousand cells per ml., and the amount of thermophilic bacteria fluctuated from 0,76 up to 1,15 thousand cells per ml. The percentages of both groups are very high (from 50–97%). There is a decrease in the amount of both groups nearly a half in the vertical saprophyte distribution. The quantity of bacteria at 0,5H depth horizon and at the bottom is practically equal. The same situation has been observed in the bottom sediments.

The analysis of long-term data has revealed the decrease amount of mesophilic forms of saprophytic bacteria after the construction of Perm thermoelectric power station (1983 – 15,6; 1984 – 3,5; 1985 – 3,6; 1990 – 1,3 thousand cells per ml. respectively). They are substituted by the thermophilic group with prevailing of mesophilic forms. It indicates the sustainability of the thermal pollution effect.

The recent studies have revealed the prevailing of mesophilic bacteria in the development of bacteria community in water during microbiocenosis at the active zone of the Perm State District Thermoelectric Power Station. The low amount of thermophilic bacteria has been observed even in the zone influenced by heated waters. The maximum difference in the quantity of these groups of bacteria has been observed in summer water samples. The low amount of thermophilic bacteria in water may be considered as the adaptation of bottom-dwelling bacteria to thermal pollution during vegetation period. The water temperature in water heated zone turned out to be favourable for the mesophilic bacteria growth and their prevailing over thermophilic bacteria quantity in the bacteria community.

The effect of heated water discharge from the Thermoelectric Power Station on the zoobenthos has been accurately studied before and after the station design. Bottom-dwelling species of the case study area affected by the thermal pollution is presented by 20 species of chironomids, 7 species of oligochaetes, 6 species of molluscs, 1 species of leeches and 1 species of crustacea [1].

To evaluate the species differences at the reference and case study areas the method of cluster analysis has been applied. Although the species differences are not significant it is possible to distin-

guish two plots with the most similar bottom-dwelling species. They are three stations at shallow water and two stations at the river channel. Natural differences in the depth gradient but not the anthropogenic effect are the key factor differentiating the fauna at the case study area. The order of species dominance at the study area is typical for the mesophilic bacteria complex and is determined by two species of low amount. The set of dominants is practically the same for all five stations. The trophic diversity index demonstrating the uniformity of food groups representativeness dramatically increases in the zone of thermal pollution. This fact testifies the unfavourable trophic situation.

The evaluation of the community structure according to the species diversity and hydrobiont uniformity, their quantitative representativeness have demonstrated that the diversity and uniformity are slightly lower at the high temperature pole gradient than at the opposite one. The stability of such communities is low. They are saved due to resilience that is an ability to return to their previous state after changes under the external influence. The change of benthos biomass during time has demonstrated that this parameter is not influenced by heated waters.

It has been revealed that communities located at one depth are similar and temperature does not affect the zoobenthos macrostructure. It only influences separate types of species and trophic structure of bottom cenosis.

### Conclusions

1. The construction of Perm thermoelectric power station has led to the decrease of oxygen during the whole navigation period. The warm water discharge has not practically influenced the water quality class according to the amount of dissolved oxygen and its biological consumption.

2. The case study area of the water body has been characterised by the bottom-dwelling bacteria adoption to the thermal pollution condition. The water temperature has been optimal for the mesophilic bacteria development.

3. Thermal pollution has not been the determining factor during zoobenthos macrostructure formation at the pre-dam part of the Kama reservoir.

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## BIBLIOMETRICAL ANALYSIS OF SAMPLING FRACTIONS OF THE NUMBER OF PUBLISHED WORKS WITH APPLICATION OF EMF, CARRIED OUT ON NEUROPHYSIOLOGICAL OBJECTS OF DIFFERENT KINDS

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Bibliometrical data on neurophysiological published works with application of electromagnetic fields (EMF) are presented. Quantitative characteristics of published works carried out on different neurophysiological objects (the brain, the cortex, neurons, nerves) during 35-year time interval (1966–2000) are considered. Among these neurophysiological published works with application of EMF predominance of published works, carried out in the brain, was established. Positive dynamics of number of neurophysiological published works of these trends was observed. Conclusion about prospects of investigations of neurophysiological effects of EMF is done.

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**Keywords:** bibliometry, electromagnetic fields, neurophysiological effects, the brain, the cortex, neurons, nerves

Neurophysiological effects of electromagnetic fields (EMF) were interested humanity for many centuries [6]. In the middle XX-th century heightened attention of researchers on influence of EMF arisen. Undoubtedly the nervous system plays an important part in reactions of organism to EMF. Neurophysiological rearrangements for different kinds of non-ionizing radiation were considered to our works in detail [1–3, 7]. The present work is devoted just to examination of quantitative characteristics of published works with application of EMF, carried on different neurophysiological objects. Bibliometrical analysis of published works on influence on EMF was not carried out before our investigation. Some results of our bibliometrical investigations of such trend partly were presented in our works [4–6].

### Materials and methods of research

Quantitative characteristics of published works in the field of neurophysiology in world during 35-year intervals in second half of the XX century (1966–2000) were considered. Investigations were carried out by means of mainly the database “Med-line” accessible through Internet. Bibliometrical data concerned published works performed in different neurophysiological objects were studied: the whole brain, the cortex, neurons, nerves. Besides in addition published works with application EMF were selected. The numbers of published works of observed trends were determined for every analyzed year with the aid of corresponding keywords.

The comparison of the parts of the numbers of published works, carried out on different neurophysiological objects, in general totality and the comparison of the numbers of published works in different time periods were performed as the comparison of two selective sampling fractions of variants.

**Table 1**

Comparison of sampling fractions of the number of published works carried  
on different neurophysiological objects with application of EMF  
and from the total number of these works during 35-year period

Factors	Parts from the total number of published works with EMF (6001)		Parts from the total number of published these neurophysiological works (705259, 180602, 237160, 278279)	
	Sampling fraction from these data (%)	Comparison with average quantity ( $U$ )	Sampling fraction from these data (%)	Comparison with average quantity ( $U$ )
1	18,53	<u>15,45</u>	0,158	0,48
2	6,82	<u>4,33</u>	0,226	<u>5,87</u>
3	4,62	<u>9,59</u>	0,117	<u>3,76</u>
4	5,90	<u>6,41</u>	0,127	<u>2,76</u>
5	8,97		0,154	

Note. 1 – the brain, 2 – the cortex, 3 – neurons, 4 – nerves, 5 – sum; statistically significant distinctions are underlined ( $U > 2,58$  corresponds to  $p < 0,01$ ).

**Results of research and their discussion**

On the whole the number of published works carried out in different neurophysiological objects reached 1401300 in 35-years period. The numbers of investigations carried out in the brain, the cortex, neurons, nerves were 705259, 180602, 237160, 278279 correspondingly. The total number of works with application of EMF was 6001. Materials concerned investigations in different neurophysiological objects under action of EMF were considered. Such published works were 2152. From them 1112 works were carried out in the brain, 409 – in the cortex, 277 – in neurons and 354 – in nerves.

Comparison the number of published works with application of EMF, carried out in different neurophysiological objects: in the brain, the cortex, neurons, nerves are presented in Table 1. The sampling fractions of obtained data from the total number of works with application of EMF and from neurophysiological works of corresponding kinds and their statistical distinctions are shown.

Table 1 shows that among published neurophysiologic works on research of action of EMF the predominance of works, carried out in the brain, took place in investigated period. The least number observed in works on analy-

sis influence of EMF on neuronal level (level part of Table 1). However among published works with EMF, carried out in different neurophysiologic objects, the same in the cortex were in the lead (right part of Table 1).

Dynamics of sampling fractions of the number of published works performed with application of EMF on different kinds of neurophysiological objects (the brain, the cortex, neurons, nerves) in five-year intervals during 35-years period and their statistical distinctions are demonstrated in Table 2.

Table 2 demonstrates compound dynamics of sampling fractions of the number of published works performed with application of EMF in different neurophysiological objects (the brain, the cortex, neurons, nerves) in five-year intervals during 35-years period. Essential increase of these values during analyzed period was found. Distinctions of values between results of 1996–192000 years in regard to 1966–191970 years reached in published works, carried out in the brain, the cortex, neurons accordingly in 14,9; 11,5; 2,7 times. Published works with EMF in nerves in interval 1966–191970 years were absent. But distinction of its values of 1996–192000 years and 1971–191975 was 11,7 times. For total number of published neurophysiological works on investigation of action EMF that distinction was 12,1 times.

**Table 2**

Dynamics of sampling fractions of the number of published works carried on different neurophysiological objects out with application of EMF during 35-year period (% from the total number of works with application of EMF)

Factors	Indices for different five-year periods						
	1966–1970	1971–1975	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000
1	16,98	13,82	9,34	11,78	18,64	21,01	20,59
2	9,34	1,63	1,77	3,26	8,15	7,46	7,95
3	7,55	6,50	3,03	2,33	5,70	4,96	4,65
4	0,00	3,25	3,28	3,72	6,93	7,58	5,55
5	33,96	25,20	17,42	21,09	39,41	41,01	38,74
Comparison with the number of works in “average” five-year period (U)							
1	0,28	1,33	4,43	3,65	0,06	1,48	1,29
2	0,67	2,83	4,31	3,18	1,07	0,57	1,06
3	0,88	0,86	1,37	2,44	1,05	0,38	0,05
4	3,47	1,33	2,09	1,98	0,90	1,60	0,40
5	0,28	2,41	6,96	6,32	1,56	2,52	1,48

Note. the numbers of works in “average” five-year period were: 1 – 18,53%; 2 – 6,82%; 3 – 4,62%; 4 – 5,90%; 5 – 35,86% (U > 2,58 corresponds to p < 0,01). Another applications as in Table 1.

### Conclusion

The results of the present bibliometrical investigations makes it possible to analyze quantitative characteristics of neurophysiological published works carried out in different objects (the brain, the cortex, neurons, nerves) with application EMF during 35-year interval of second half of XX century (1966–192000 years). The number of published works with application EMF carried out the brain predominated. Second place belonged to works carried out in the cortex.

Sampling fractions (%) of received data from the total number of works with of EMF and from the total number of works, carried out on certain neurophysiological objects, were considered.

Positive dynamics of the number of neurophysiological published works, carried out on different objects with application EMF during 35-year interval was observed.

Unfortunately neurophysiological researches of effects of EMF will have further development in XXI century [6].

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## THE STATE OF VISUAL ANALYZER WHEN USING THE DRUG THIOGAMMA AT TYPE I DIABETES

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31 patients were examined with a diagnosis of Type I diabetes with use of clinical- somatic and neurological examination. The authors attempted to analyze the visual analyzer, its functional state and the response to the stimulus of cortical structures. In this regard, all patients underwent neuropsychological examination using visual induced potentials alternated on a chess type pattern. In order to evaluate the effectiveness of the drug Thiogamma, evoked potentials were examined before and after the treatment. The study allowed to assert that the structures of the visual analyzer develops an increase in the latent period with Type I diabetes, which corresponds to demyelination processes. During the use of the drug Thiogamma, these changes are reduced significantly, as reflected in the reduction of latency and increase the amplitude of the response evoked potentials.

**Keywords:** diabetes, evoked potentials, visual analyzer

Among the pathological conditions of the nervous system, resulting in diseases of the endocrine glands, there is a special place for neurological disorders with diabetes (D). This is due not only to the prevalence of these disorders and their severity, a significant influence on the prognosis and a quality of life. Diabetes is one of the most common diseases in the world. According to experts, by 2025, the total number of people with diabetes will reach 324 million people [8]. Currently in Russia there are about 8 million people suffering from diabetes and the number is continuously growing [2]. Despite the fact that the proportion of type I diabetes from all diabetes forms is not more than 10–15% [2, 3], this form is the most important medical and social health problem because it often occurs during childhood and adolescence and is might bring severity, disability and often early death [2].

Vascular lesions are observed in all forms of diabetes. However, type I diabetes when the main cause of disability is high is microangiopathy which leads to diabetic retinopathy (DR) [6, 7]. It is noted that diabetes is one of the first places as a cause of blindness and low vision in all age groups. Patients with diabetes have 25 times higher risk of blindness than people without diabetes [4, 5]. In this regard, the study of the visual analyzer state with type I diabetes is particularly important.

**Objective:** To clarify the state of neurophysiological pathways of the visual analyzer of patients with type I diabetes before and after treatment.

### Materials and methods of research

The study 31 patients (12 men and 19 women, mean age  $21,3 \pm 2,10$  years) with type I diabetes were involved and were treated at the endocrinology department of

Stavropol City Clinical Hospital № 3. The average duration of the disease was  $5,1 \pm 2,1$  years long. All patients underwent clinical and laboratory examination, including determination of antibodies to myelin basic protein (MBP), which were determined by enzyme immunoassay analysis using a kit of reagents developed by N.E. Yastrebova and N.P. Benaiah (Company “Navi”, Moscow).

Most examined were in a state of decompensating diabetes. The clinical status of the visual analyzer in patients was studied together with an ophthalmologist. The criterion for the possible study was the presence of type I diabetes with an initial stage of diabetic retinopathy or without changes in the fundus. From the group of patients studied were excluded those with anisometropia, myopia greater than 1,0 diopters, astigmatism, amblyopia, exophoria, color abnormalities, any other (except for diabetic retinopathy), eye diseases or injuries, none of who had photo laser coagulation before.

In order to evaluate the visual analyzer neurophysiological study was conducted using the unit “NeuroMEP/4” made by a firm “NeuroSoft” with computer processing, developed by Russian Academy MTN in Ivanovo city. The latency period (LP) and the amplitude of the response caused by the visual evoked potential (VEP) was studied on the reversible black and white checkerboard pattern. The advantage of this study is the possibility to select in the graphical display of the fundamental wave P100 most accurately, which corresponds to the activation of the 17th (primary visual cortex) and 18th (visual associative cortex) pole according to Brodmann [1].

The method allows to trace the nerve impulse within the optic fibers from the cells of the retina (rods), the optic nerve, optic tract and through the mid-brain structures to the occipital lobe of the cerebral cortex [1]. This method also gives a quantitative estimate of the speed of the optic analyzer. The study was conducted according to standard procedures. The active electrode was placed over the occipital area in O2 area, O1 international chart “10–20%” and the ground electrode on the forehead (at Frz point). Ipsilateral at the point Cz. The impedance under the electrodes was not higher than 5 kW.

Stimulation was carried out on alternate black and white checkerboard pattern alternately on the left and right eye in a darkened room with a prior adaptation in a sitting position. Time of analysis – 500 ms. The number of averaging – 70–100. Components N75 response, P100

and N145ms were evaluated. Advantageously, emphasis was placed on the study of the basic component P100 and wave of amplitude N75-P100.

In order to clarify the status of bioelectric activity (BEA) of cortical brain structures the electroencephalogram (EEG) was studied using the unit "Neuro-MEP/4". A visual and computer analysis of 16 monopolar derivations was conducted: Fp1, Fp2, F3, F4, F7, F8, C3, C4, P3, P4, O1, O2, T3, T4, T5, T6 according to international scheme "10-20%" with the reference electrode on the ipsilateral ear lobe. The era of the analysis was 4 seconds at a sampling rate of 250 in 1 sec. Spectrum of power density in each lead, which was normalized to its power to total EEG, was analyzed with assigned step of 0,125 Hz between 0,5 to 35 Hz interval. The ground electrode was placed on the frontal pole – FPZ with impedance at 40 ohms not more. The following EEG frequency ranges was defined:  $\delta$  – 0,5–3,5 Gts,  $\theta$  – 4–7 Gts,  $\alpha$  – 8–13 Gts,  $\beta_1$  – 14–20 Gts,  $\beta_2$  – 21–40 Gts.

The examination of patients was performed before and after basic treatment, the foundation of which was the use of the drug Thiogamma. Last injection was at a dose of 600 mg intravenously per 200 ml. of saline solution for 10 days and then performed neurophysiological study again. During the treatment of patients with diabetes modern treatment principles was used: along with diet and drug therapy, applied training programs. The average daily dose of insulin was  $39,1 \pm 2,32$  units. All patients were treated with human insulin firm Novo-Nordisk and Eli Lilly according to intensified insulin therapy. The control group consisted of 15 healthy adults, matched to age and sex.

For the analysis of the results obtained using the arithmetical value ( $M$ ) and error ( $m$ ), standard deviation ( $\delta$ ). Reliability of differences of values was evaluated using Student's test ( $t$ ).

### Results of research and their discussion

During the clinical examination 18 patients (58.1%) were diagnosed with diabetic encephalopathy, a demonstration of which were complaints asthenic character: general weakness, fatigue, decreased performance, anxiety, emotional lability, impaired concentration, loss of memory. In 67,7% of cases detected cephalgic syndrome. It should be noted that the headache often had the character of compression, compressing the type "tide hat".

Symmetric distal polyneuropathy was met among 28 (90,3%) patients At the same

time some complained about tingling, numbness, coldness of feet and sometimes hands or a feeling of burning, pain in the limbs, which often amplified at night or at rest. Was identified reduction of pain, temperature or vibration sensitivity according to the type "socks" and "gloves", reduction of reflexes, tone, in some cases moderate movement disorders. Gi-postezii gradually was spreading from the distal portions of the legs and arms to the proximal portions.

In all cases, patients reported vegetative dystonia syndrome as dermographism diffuse, diffuse hyperhidrosis and acrocyanosis. In 3 cases, patients reported the development of lightheadedness. Due to the destruction of vegetative fibers in 5 cases (16.1%), patients developed vegetative-trophic disorders in the form of arthropathy which was shown as progressive deformity of the ankle and foot joints.

11 patients (35.5%) had various degrees of depression, which in our opinion is a consequence of the disease.

Conducted neurophysiological examination revealed a number of patterns (Table). After analyzing the results of SGP was found that patients with type I diabetes compared with the control group surveyed in terms of P100 wave there was an increase in the LP to the right and left of the treatment, which concluded to  $119,3 \pm 2,58$  ms vs.  $103,1 \pm 1,72$  ms in the control ( $p < 0,05$ ).

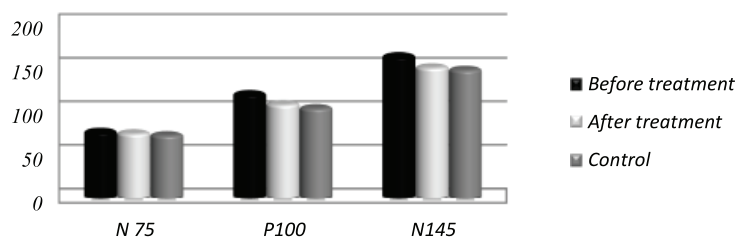
Also a significant change in this period PL indices was diagnosed in the late EP components. So PL N145 waves was  $172,3 \pm 3,66$  ms vs.  $151,3 \pm 2,22$  mV in the control group ( $p < 0,05$ ). Should be noted that the elongation of LP P100 wave was observed in the overwhelming majority of patients (87,1% in the cases).

Conducting course of treatment using basic therapy Thiogamma drug revealed a tendency to restore the LP (Figure).

VEP dynamics of quantitative indicators in the examined group of patients with type I diabetes before and after treatment ( $M \pm m$ )

Period	D I type ( $n = 31$ ) before treatment	D I type ( $n = 25$ ) after treatment	Control group ( $n = 15$ )
Latent, period (mc)			
N75	$76,1 \pm 2,81$	$74,3 \pm 3,93$	$72,1 \pm 2,09$
P100	$119,3 \pm 2,58^*$	$110,6 \pm 2,74$	$103,1 \pm 1,72$
N145	$172,7 \pm 2,73^*$	$149,9 \pm 2,21$	$151,3 \pm 2,22$
Amplitude (mV) P100	$4,3 \pm 1,63$	$7,2 \pm 1,36$	$8,1 \pm 1,21$

Note. \* – Significant differences ( $p < 0,05$ ) – in the control group.



Indicators of VEP components relative to the control group before and after treatment using Thiogamma ms.

Analysis of wave amplitude N75-P100 showed that the patients had a reduction in the amplitude to the response to presented stimuli. So examinees amplitude of wave N75-P100 was  $4,3 \pm 1,63$  mV, that characterized the depression of visual cortical structures. To verify the results, in particular, changes in the depressive nature of the available research was conducted EEG research parallel with the brain registration of BBA. The results of the study noted that neurophysiological EEG indexes, their frequency and amplitude characteristics are substantially comparable to the control group data. Patients' with diabetes index was the average alpha rhythm amplitude amounted to  $75,8 \pm 2,3$  mV, the average frequency of alpha rhythm –  $9,6 \pm 1,1$  Hz, the average index – 71%. EEG results characterize that brain BBA in cortical visual areas and remain functionally in the state close to the control group. This suggests that the reduction of the amplitude response according to VEP results is associated with a reduction in the pulse flow along the fibers of the optic analyzer and as a result a decrease in the number of neurons that activate a response in the cortex presented stimuli.

In this regard, we believe that the decline in conductivity along the fibers of the optic analyzer may result from the demyelination processes. To clarify these changes, immunological studies have been performed, which are related to the specification of the concentration of IgG antibodies to myelin basic protein. It was found that the concentration of IgG antibodies to MBP in diabetic patients before the treatment was higher than the control group and amounted to  $156,2 \pm 4,22$  and  $50 \pm 2,1$  g/ml. These immunological changes may further indicate demyelination processes, which result in a decrease of conductivity along the fibers of the optic analyzer.

The existing theory of the transitioning process associated with the assessment of brain response to impulse action is related to the whole brain system: corticocortical homeostasis, stem reticular formation, responsible for the maintenance of the processes of sleep – wakefulness, attention, fit [1]. In our opinion, the results of impulse excitation and in particular VEP allow an objective assessment not only of the visual

analyzer, but in general have an objective understanding of the functional state of the brain.

### Conclusion

Thus, these results indicate that the type 1 diabetic demyelination processes occur in the structures of optic analyzer, which help to reduce the “flow” in pulse conduction visual cortical visual analyzer structure that leads to a reduction in cortical response reaction to presented stimuli. Using Thiogamma drug in the treatment of type 1 diabetes can significantly improve the metabolic processes in the structures of the visual analyzer, and thereby restore their functional state.

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## INGUINAL LYMPH NODES AFTER COMBINED OZONE- AND PHYTOTHERAPY AT THE LATE STAGE OF ONTOGENESIS

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We have done the analysis of the structural and functional zones of inguinal lymph nodes, taking into account age and phytotherapy in the experiment. We have obtained results which show a decrease in the functional activity of the lymphoid parenchyma on the background of the involution and sclerotic processes in the lymph node. We implemented the idea of enhancing nonspecific resistance by ozone and phytocorrection of the structure and function of the lymph node, which has undergone age-related changes. Positive effect was achieved through changing the size of the lymph node compartments, preservation of lymphoid nodules and strengthen neolymphogenesis at the late stage of ontogenesis. We review phytotherapy as a means of raising nonspecific resistance of the organism.

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**Keywords:** lymph node, ozone- and phytotherapy, gerontology

The immune system has a leading role in the formation of nonspecific resistance of the organism. The structure of the immune system presents lymphoid tissue and in particular lymph nodes. Lymph nodes have any evolutionary and ontogenetically to ensure the immune status under the action of different environmental factors. Aging lymphoid tissue occurs with age and the inevitable decline of nonspecific resistance of the organism, especially in old age periods of life. A search of means and methods is a priority when you need to adjust the immune status and increase the body's resistance. The solution of one of actual problems of modern gerontology and lymphology is search of the means strengthening neolymphogenesis. This problem may be decided by overcoming affirmation of modern medicine that «new lymphoid organs are not formed at a late stage of ontogenesis» [4, 7, 8]. Ozone- and phytotherapy have the greatest interest among other treatment methods. They are used in endoecological rehabilitation on the basis of existing modern concepts of protective systems [7] and phytolymphonutritiology [4].

The purpose of the study was to evaluate the effect of combined ozone- and phytotherapy on the structure and function of the lymph node, which had undergone age-related changes.

### Materials and methods of research

The experiment was conducted with 160 white rats male Wistar with conventionally selected age groups: young animals at the age of 3–5 months (control group) and old animals aged 1,5–2 years (comparison group) taking into account the ratio of life expectancy of rats and humans. The animals had free access to water and were put on a standard diet. In elderly and senile age reduced function of the lymphatic system, which necessitates the use of lymphotropic technologies correction to increase nonspecific resistance of the organism. The choice is made in favor of ozone and phytotherapy, as they possess adaptogenic and lymphotropic effects of the action [4]. Orig-

nal herbal collection used in a daily dose of 0,1–0,2 g/kg during one month in these animals of different ages. A herbal combination including *Bergenia*, *Rhodiola rosea*, *Hedysarum*, *Rosa majalis*, *Thymus*, blueberry, cowberry, currant leaves and dietary fiber. The main active bioactive substances of plants are flavonoids, arbutin, dietary fiber, trace elements. Application of ozonized olive oil was carried out on the region of inguinal lymph nodes during 15–20 minutes every other day (total 14 procedures). Inguinal lymph nodes were investigated with histological method [3]. Histological sections of lymph nodes were stained with hematoxylin-eosin, azure-eosin and exposed to morphometric analysis [2] using the program Image-Pro Plus 4.1. The study used a statistical method with the arithmetical mean, the average squared error and the scientific validity of the data at  $p < 0,05$  using the program StatPlus Pro 2009, AnalystSoft Inc.

### Results of research and their discussion

It is shown that with age lymph nodes start suffering from functional load for involution in the presence of the morphological equivalents of compensation. The size of structural and functional zones changes and the lymph node structure becomes non-homogeneous (Table 1). At late stage of ontogeny is manifested by increase in 1,4 times of capsules ( $1,62 \pm 0,07\%$  compared with  $1,16 \pm 0,09\%$  in the control), in 1,6 times of the cortical plateau ( $1,90 \pm 0,08\%$  compared with  $1,20 \pm 0,09\%$  in the control), in 1,3 times of paracortex ( $8,94 \pm 0,49\%$  compared with  $7,14 \pm 0,67\%$  in the control), in 2,3 times of lymphatic sinus ( $2,94 \pm 0,20\%$  compared with  $1,30 \pm 0,12\%$  in the control) on the background of the decrease in 1,2 times of lymphoid nodules with germinal center ( $1,37 \pm 0,12\%$  compared with  $1,61 \pm 0,17\%$  in the control). The observed changes of the lymph node compartments are a reflection of the decrease of lymphoproliferation, sclerosis, involution of lymphoid tissue and antagonism of humoral and cellular elements of the immune system. All this leads to decreased immune function at a late stage

of ontogenesis. These changes are induced by an increasing disproportion between influx and efflux from lymph nodes. They mostly affect those lymph nodes, which did not underwent involution and conserved structural and functional zones constituting lymphoid nodule. It is therefore preservation of lymphoid nodule that defines the functions of lymph nodes significant at the late stage of ontogenesis and necessary for performing drainage and detoxification functions in the lymphatic region.

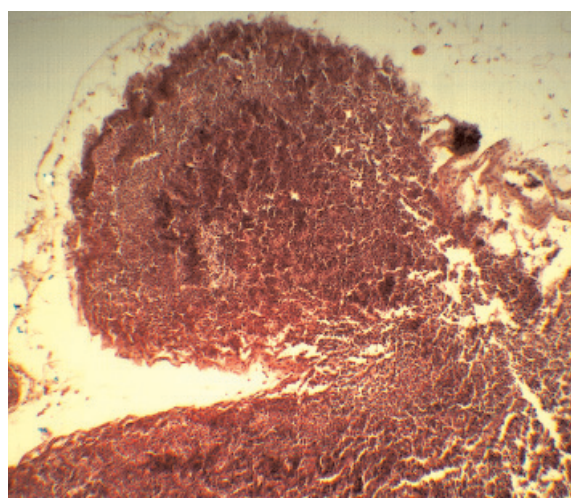
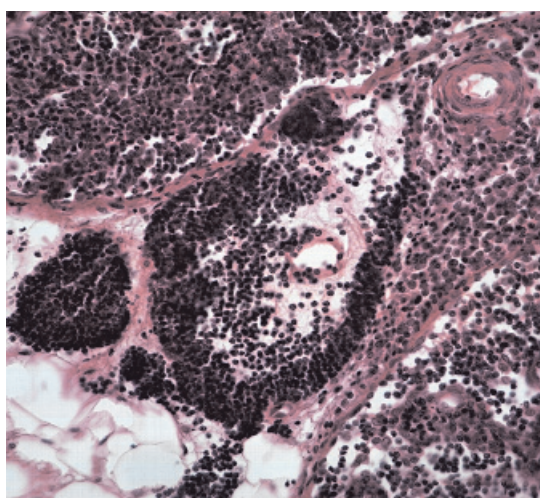
The combined ozone- and phytotherapy influences the structural organization of lymph nodes that underwent age-related changes (Table). There is a reduction in 1,3 times areas of the cortical plateau ( $1,45 \pm 0,19\%$  com-

pared with  $1,90 \pm 0,08\%$  without correction), paracortex ( $7,17 \pm 0,31\%$  compared with  $8,94 \pm 0,42\%$  without correction) and lymphatic sinus ( $1,61 \pm 0,11\%$  compared with  $2,94 \pm 0,20\%$  without correction). There is increased in 1,8 times the area of lymphoid nodules with germinal center ( $2,48 \pm 0,25\%$  compared with  $1,37 \pm 0,12\%$  without correction), in 1,2 times the area of medullary cords ( $6,04 \pm 0,48\%$  compared with  $5,02 \pm 0,34\%$  without correction). Ozone- and phytotherapy contributes to the preservation of lymphoid tissue and enhances immune potential of lymph nodes to the increase in proliferation and migration of lymphoid cells and optimize the size of sinus system at a late stage of ontogenesis.

The area of lymph node structures of young and old animals after ozone and phytotherapy, %

Structures of a lymph node	Young animals (3–5 months)		Old animals (1,5–2 years)	
	Control (without correction)	Ozone and phytotherapy	Control (without correction)	Ozone and phytotherapy
	1	2	3	4
Capsule	$1,16 \pm 0,09$	$1,07 \pm 0,08$	$1,62 \pm 0,07^*$	$1,74 \pm 0,11$
Subcapsular sinus	$0,57 \pm 0,07$	$0,59 \pm 0,05$	$0,41 \pm 0,04$	$0,58 \pm 0,05$
Cortex plateau	$1,20 \pm 0,09$	$1,57 \pm 0,16$	$1,90 \pm 0,08^*$	$1,45 \pm 0,19$
Lymphoid nodule with germinal center	$1,16 \pm 0,06$	$1,32 \pm 0,11^*$	$1,24 \pm 0,08$	$1,28 \pm 0,11$
Lymphoid nodule without germinal center	$1,61 \pm 0,17$	$1,85 \pm 0,21$	$1,37 \pm 0,12^*$	$2,48 \pm 0,25^\circ$
Paracortex	$7,14 \pm 0,67$	$5,84 \pm 0,44$	$8,94 \pm 0,49$	$7,17 \pm 0,62$
Medullary cords	$5,20 \pm 0,32$	$5,02 \pm 0,38$	$5,02 \pm 0,34$	$6,04 \pm 0,48$
Medullary sinus	$1,30 \pm 0,12$	$0,94 \pm 0,08$	$2,94 \pm 0,20^*$	$1,61 \pm 0,11^\circ$

Note.  $*P_{1-2,3} < 0,05$ ,  $^\circ P_{3-4} < 0,05$  – the differences were significant.



Lymphoid infiltration with separate lymphoid nodule (left) and fragmentation of parts of the lymph node (right) after ozone and phytotherapy at a late stage of ontogeny. Stained with hematoxilin and eosin. The magnification of ocular 7x by objective 4x

There is information about neolymphogenesis in the literature [1, 5, 6, 8]. We have established the effect of neolymphogenesis after ozone and phytotherapy. We revealed the ectopic formation of lymphoid follicles in the subcapsular zone and in the medullary substance of lymph node. Evidence of the formation of lymphoid follicles is the absence of CD38+cells [7]. Ozone and phytotherapy enhances lymphoproliferation and leads to the accumulation of lymphocytes and the formation of lymphoid nodules (follicles) outside the lymph node (Figure). Regeneration of lymphoid tissue outside the lymph node is a sign of compensation for age-induced changes. There is hyperplasia of the individual structural and functional areas, and the fragmentation of lymph node due to the separation of parts of the cortex (Figure). Small lymphoid nodules often found in the tissue around inguinal lymph nodes. The formation of new lymphoid structures located outside of the lymph node is the result of changes of lymphatic drainage after ozone and phytotherapy. Ectopic accumulations of lymphoid cells are called «tertiary lymphoid organs» and they are described usually in pathological situations associated with varying degrees of immunodeficiency [1, 6, 8]. We consider neolymphogenesis as manifestation of regeneration, resulting in increased immunodeficiency at the late stage of ontogenesis after phytotherapy.

Thus, at the late stage of ontogenesis, the structure of lymph nodes is reorganized, which reflects the general process of ageing. The combined ozone- and phytotherapy has a modulating effect on structural and functional zones accompanied by an increasing proliferation of lymphoid cells and intense neolymphogenesis. The result is of practical importance to enhance the nonspecific resistance of the organism and efficiency of the endoecological rehabilitation in elderly and senile age.

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## CLINICAL NEUROLOGICAL CHARACTERISTIC OF PATIENTS WITH MULTIPLE SCLEROSIS IN VIEW OF THE SEVERITY CONDITION

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79 patients were examined (57 women and 22 men) at the average age of  $34,31 \pm 4,7$  years old with a diagnosis of multiple sclerosis (MS). The study enabled to record the patients with recurrent MS progression dominating in the group of interest. In that MS form, patients with the clinical score of mild disability dominated on the EDSS scale. The number of patients with medium severity prevailed in the secondary progressive MS course with a 3-fold increase, and increased by 5,5 times in the severe MS course. In all groups, coordination and movement disorders had the highest incidence of neurological symptoms with highest intensity in the severe group. More than 90% of patients with mild severity had only disorders in the reflex sphere. The incidence of pelvic disorders increased as the conditions deteriorated with maximum dysfunction in patients with severe MS. Basically, all patients with different MS forms had psychopathological disorders with different severity, which incidence was highest in Group 3 (86,4%). A similar trend was recorded in the intensity scale of cerebral function disorders, where cognitive impairments were recorded in more than 65% of cases with their increase as the demyelination processes of the nervous system impaired, being one of the most important clinical manifestations of chronic demyelinated process in MS.

**Keywords:** multiple sclerosis, demyelination, disability

We have to admit that multiple sclerosis (MS) is a problem that has not been solved so far [2, 3, 6, 7, 9, 10, 11]. On the other hand, the today's day brings us hope for a possible breakthrough in treatment and early diagnosis of the disease [5, 8, 9, 10]. The MS prevalence is large enough [1, 4, 7]. The MS clinical course may be caused by different diseases, resulting the patient's condition in different disability states in most cases. In this regard, understanding potential neurological disorders in different disease courses is supposed to enable to avoid MS fatal consequences in a lot of cases, where early detection of the disease will be especially important.

**The research is aimed to:** study the clinical and neurological characteristics in patients with multiple sclerosis taking into account the disease severity.

### Materials and methods of research

The study included 79 patients (57 women and 22 men) at the average age of  $34,31 \pm 4,7$  years old with a diagnosis of multiple sclerosis, which was previously confirmed in the clinics of Moscow, Rostov-on-Don, Stavropol. They were observed in the clinics of the

Chechen Republic at the date of clinical examination. The following clinical forms of the disease have been identified in the total number of patients: recurrent (RMS) – 56,9%, secondary progressive (SPMS) – 18,9%, and primary progressive (PPMS) – 24,2%. The distribution by age and type of MS course is given in Table. The average duration of the disease, taking into account the clinical form was as follows: RMS –  $3,3 \pm 2,2$  years, SPMS –  $9,1 \pm 4,2$  years, PPMS –  $2,7 \pm 1,9$  years. The assessment of functional system impairment was carried out according to the J.F. Kurtzke scale (1983). The assessment of the disability status in patients with MS was carried out using the Kurtzke Expanded Disability Status Scale (EDSS) (J.F. Kurtzke). The MS mild severity was between 1 and 3 ( $2,39 \pm 0,1$ ), medium severity – between 4 and 6 ( $5,3 \pm 1,1$ ), heavy severity – from 7 points and higher ( $7,6 \pm 1,4$ ). In this regard, all patients were divided into 2 groups according to the severity. All patients underwent the brain MRI in T1, T2 and FLA IR modes (MR Signa HD×3.0 Tc [GE]).

Most of the studied patients were in the condition of relative remission of the disease. The inclusion criterion was the patient's diagnosis of "multiple sclerosis" with available features of the disease course, such as incidence of clinically distinct acute conditions and rate of increased neurological deficit, lack of autoimmune diseases. The people with MS and progressive acute condition of the disease, history of craniocerebral injuries, and neuroinfections were excluded from the number of studied patients.

Distribution of patients by age and type of multiple sclerosis course

Age (s)	RMS	SPMS	PPMS	Total
18–29	32 (40,5%)	4 (5,1%)	3 (3,8%)	39 (49,4%)
30–39	9 (11,4%)	8 (10,1%)	6 (7,6%)	23 (29,1%)
40–50	4 (5,0%)	3 (3,8%)	10 (12,7%)	17 (21,5%)
total	45 (56,9%)	15 (18,9%)	19 (24,2%)	79 (100%)

The calculation of arithmetic means (M), their errors (m), and standard deviation ( $\delta$ ) were used for the evaluation of the results. The significance of mean differences was determined using the Student's t test (t).

### Results of research and their discussion

As a result of clinical examination 29 (36,7%) patients with MS had a mild severity (Group 1). In all cases, the patients in that group had RMS. In 15 (51,7%) patients the severity of neurological disorders on the EDSS scale was 2,0 points, in 11 (37,9%) patients – 2,5 points, 3 (10,4%) patients – 3 points. In the neurological status, the pyramid insufficiency such as parareflexia and available paresis with different severity prevailed in those patients, where the reduction in muscle strength varied between 1,5 and 3 points. In 26 (89,7%) cases we recorded anisoreflexia along with loss of abdominal reflexes and pathological (feet, hand) reflexes. In 7 (24,1%) cases the motor disturbances had different characteristics: monoparesis – in 2 (6,9%) patients, paraparesis – in 5 (17,2%) patients. The total clinical score reflecting the severity of motor impairments on the functional scale (FS 1) was  $1,4 \pm 0,8$ .

In 23 (79,3%) patients, pathological cerebellar changes with mild coordination disorders like mild ataxy, intentional tremor, dysmetria were identified when performing coordination tests. The total clinical score reflecting the severity of coordination impairments on the functional scale (FS 2) was  $1,41 \pm 0,9$ .

17 (58,6%) patients had a combination of pyramid cerebellar impairments associated with hypoesthesia, presence of paresthesia or feeling of numbness in one or both extremities. On objective examination, "mosaic" areas of superficial sensitivity infringements have been identified. The impaired proprioceptive sensitivity was recorded in 5 (17,2%) patients. In this case, the total clinical score, reflecting the severity of sensory disorders on the functional scale (FS4) was  $1,1 \pm 0,8$ .

The impairments in the pelvic organ function according to the type of urgency combined with the difficulty in urinary bladder emptying (detrusor-sphincter dyssynergia) were identified in 6 (20,7%) patients and were periodic. It corresponded to a total clinical score on the scale (FS 5)  $0,41 \pm 0,9$ .

In 13 (44,8%) patients, the impairments in the stem structure were identified. Thus, in 2 (6,9%) cases the impairments in the oculomotor nerve were recorded, in 5 (17,2%) cases the failure of the facial nerve in the central type, and in 4 (13,8%) patients the tongue deviation were recorded. The total clinical score on the scale (FS 3), reflecting the degree of stem dysfunction made  $1,68 \pm 1,5$ .

It should be noted that the manifestations associated with the impaired background mood were recorded in that group. Thus, in 16 (55,2%) patients mild impairments of background mood were identified, which could not affect the EDSS scale score. In 12 (41,4%) cases, patients reported rapid fatigability, defective memory, impaired concentration, attention, rigid thinking. The total clinical score (FS 7), which reflects the impairment degree of mnesic functions, made  $1,11 \pm 0,8$ .

In 28 (63,3%) patients with MS, the medium severity was recorded (Group 2). The clinical manifestations of MS with medium severity were characterized by the present persistent focal neurologic deficit. In this group, 16 (57,1%) patients had a recurrent clinical course, 8 (28,6%) patients – secondary progressive, and 4 (14,3%) patients – primary progressive clinical course. In all cases, the pyramid cerebellar syndrome with different severity was identified in Group 2 compared to Group 1, where disturbance of the pyramid and cerebellar system was recorded in 24,1% and 79,3%, accordingly.

The pyramid disturbances were identified in 19 (67,9%) patients such as moderate or marked paresis. Monoparesis was identified in 4 (14,3%) patients, paraparesis – in 6 (21,4%) patients, hemiparesis – in 4 (14,3%) patients, tetraparesis – in 5 (17,9%) patients. The total clinical score reflecting the severity of motor impairment on the functional scale (FS 1) made  $3,7 \pm 0,5$ , which is 2,64 times more compared to Group 1. The intensity of stato-coordination disorders on the functional scale (FS 2) and the total clinical score was  $1,99 \pm 0,9$ , which is 1,38 times more than in Group 1. 15 (53,6%) patients had sensory disorders such as reduction in deep sensibility, which were clinically manifested in the form of sensitive ataxia that is 36,4% more than in Group 1.



The total clinical score reflecting the severity of sensory disorders in the functional scale (FS 4) was  $2,4 \pm 0,7$ , which exceeded two-fold the total clinical score in Group 1.

The impaired function of pelvic organs was recorded in 12 (42,9%) patients, which is 22.2% more compared to Group 1. The total clinical score on the functional scale (FS 5) made  $1,05 \pm 1,3$ , which is 2,56 times more compared to Group 1.

In 8 (28,6%) cases oculomotor apraxia was diagnosed. Nystagmus was detected in 15 (53,6%) cases, which exceeded the manifestation data twofold compared to Group 1. The total clinical score on this scale (FS 3), impaired stem functions made  $2,2 \pm 0,8$ , which is 76% more compared to Group 1.

The psychopathologic changes were detected in 18 (64,3%) cases, and were manifested in the form of mood lability, while 8 patients (28,6%) had a reduction in cognitive and mnemonic processes, as well as reduced attention concentration. The total clinical score reflecting the impairment of cerebral functions (FS 7) was  $1,41 \pm 0,7$ , which is 1,41 times more compared to Group 1.

In 22 (27.8%) cases we recorded severe MS (Group 3), including secondary progressive MS in 7 (31,8%) patients and primary progressive clinical course in 15 (68,2%) patients. The clinical presentation of severe MS included the presence of gross significant focal neurologic impairment. Motor disturbances dominated in the neurological status, which formed the basis of impaired pyramid and cerebellar connections and structures identified in each case (100%). The impaired function of pyramid system included hypertonia, hyperreflexia, and pathological reflexes. Manifestation of tetraparesis, paraplegia or hemiplegia with different intensity was usually combined with foot or knee-cap clonus. The total clinical score reflecting the intensity of motor disturbances in the functional scale (FS 1) made  $4,4 \pm 0,8$ , which is 3,14 times more compared to Group 1, and 1,19 times more in Group 2.

6 (27,3%) patients had a coordinatory symptomatology such as marked intentional tremor, significant discoordinated impairments that reduced the quality of patient's life a lot. 4 (18,2%) patients reported head tremor when getting up out of bed. In seven (31,8%) cases tremor was combined with

postural tremor. The dysfunction in the cerebellar system was manifested in the form of hypermetria, adiadochocinesia, Homs symptom, scanning speech. The total clinical score on the functional scale (FS 2) made  $2,4 \pm 1,2$ , which is 1,7 times more compared to Group 1, and 1,21 times more compared to Group 2. It should be noted that the objective assessment of cerebellar dysfunction was very complicated due to the presence of extremity paresis with more than 3 points in a number of patients. This fact explains why patients in Group 3 did not have a significant increase in the clinical score of the cerebellar function assessment.

The total clinical score reflecting the intensity of stem functions (FS 3) made  $2,4 \pm 0,6$  and was reliably similar to the value of Group 2. The sensorium was presented by prolapse of proprioceptive sense, which was recorded in 7 (31,8%) patients without any significant differences in percentage compared to Group 2. The total clinical score reflecting the severity of sensory disorders on the scale (FS 4) made  $2,4 \pm 0,6$  and did not have any significant differences compared to Group 2.

The impaired function of pelvic organs was identified in 17 (77.3%) cases, which is 34.4% more compared to Group 2. The total clinical score was (FS 5)  $1,6 \pm 0,7$ , which is 3,9 times more compared to Group 1, and 1,5 times more compared to Group 2. The psychopathological changes were recorded in 19 (86,4%) patients, such as euphoria, judgment decline to their condition, apathy or different depression. The total clinical score reflecting the degree of impaired higher cortical functions (FS 7) made  $1,7 \pm 0,9$ , which is 1,53 times more compared to Group 1, and 1,21 more compared to Group 2.

### Conclusion

Thus, the study carried out in the Czech Republic enabled to determine that the patients with the recurrent MS progress dominated in the group of interest. In that MS form, patients with the clinical score of mild disability dominated on the EDSS scale.

The number of patients with medium severity prevailed in the secondary progressive MS course with a 3-fold increase, and the severe MS course increased by 5,5 times. In all groups, coordination and movement

disorders had the highest incidence of neurological symptoms with highest intensity in the severe group. More than 90 % of patients with mild severity had only disorders in the reflex sphere. The predominance of sensory disorders was not found in any group. The incidence of pelvic disorders was increasing as the conditions deteriorated with maximum dysfunction in patients with severe MS.

Basically, all patients with different MS forms had psychopathological disorders with different severity, which incidence was highest in Group 3 (86,4 %). A similar trend was recorded in the severity scale of cerebral function disorders, where cognitive impairments were recorded in more than 65 % of cases with their increase as the nervous system demyelination processes impaired, being one of the most important clinical manifestations of chronic demyelinating process in MS.

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## CHANGES HUMORAL IMMUNITY AND ANTIGENS HLA SYSTEM IN ACUTE PANCREATITIS

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In patients with acute pancreatitis noted antibodies to endogenous antigens: s-DNA – 58,5%, d-DNA – 53,7%, n-DNA – 51,2%, trypsin – 42,7%, insulin – 28,1% and pancreatic tissue antigens – 19,5%, and increase in the level of serum immunoglobulins and circulating immune complexes. In conjunction with an increase in frequency of detection in patients with acute pancreatitis antigen system HLA A1, B8, B18, associated with dysregulation between T- and B-functioning immune system, changes in the state of humoral immunity are genetic and humoral mechanisms that mediate the development of autoimmune reactions in acute pancreatitis.

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**Keywords:** acute pancreatitis, humoral immunity, antigens of HLA system

Acute pancreatitis in recent decades continues to be one of the most common disease among acute diseases of the abdominal cavity, there is an increase in the number of patients with acute pancreatitis and increase the share of destructive forms of lesions of the pancreas. At present, the immune changes detected in acute surgical diseases of the abdominal cavity, considered as a factor that largely determines the course of the disease, contributing to the maintenance of the inflammatory process and reducing the effectiveness of reparative processes [1–3, 16, 17, 20, 21]. The study of humoral and cellular immunity in pancreatitis indicates a change in the main humoral factors [4, 9, 13, 14]. Study Association of HLA phenotype, and the intensity of the humoral immune response to antigens of the pancreas, the level of production flogogennys agents humoral and cellular genesis in pancreatitis matters to define the role of genetically determined mechanisms in the pathogenesis of inflammatory diseases of the pancreas and introducing prospects pathogenetically oriented methods of treating a disease using anticytokine correction methods [7, 8, 15, 19, 23].

**Aim.** To study the frequency of detection of antibodies to structural and secretory component of the pancreas in patients with acute pancreatitis and to consider possible changes in humoral immunity association with certain HLA phenotypes.

### Materials and methods of research

We examined 110 patients with acute pancreatitis who have studied the condition of humoral immunity to structural (antigens from the tissues of the pancreas) and secretory (insulin and trypsin) pancreatic components, to DNA: single- stranded (s-DNA), denatured (d-DNA), a native (n- DNA)- in the reaction of passive hemagglutination by Boyden. According to the classification of acute pancreatitis patients studied were di-

vided into two groups: patients with dropsical (regressing, abortive) form of acute pancreatitis – 79 patients and patients with acute destructive pancreatitis (fatty and hemorrhagic pancreatic necrosis) – 31 patients. Among patients with dropsical form of acute pancreatitis were 45 women and 34 men, with a destructive form – 17 women and 14 men.

Identification of HLA antigens were determined by complement-dependent cytotoxicity [15, 16]. We have panels 28 – I and 28 – II Institute of Hematology and Blood Transfusion (Saint-Petersburg) of 116 sera to identify specific antigens of locus A – 14, locus B – 18 and locus C – 5 of HLA system. The immunoglobulins of the main classes (A, G, M) were investigated by radial immunodiffusion by G. Mancini, using monospecific serum immunoglobulin A, G, M. Circulating immune complexes were determined by a method based on the selective precipitation of antigen-antibody complexes in 3,75% polyethyleneglycol solution, followed by photometric examination.

### Results of research and their discussion

In patients with acute pancreatitis, we noted the presence of humoral immunity responses to all antigens studied. Of antibodies to s-DNA found at 58,5% in the d-DNA – 53,7%, n-DNA – 51,2% trypsin – 42,7% insulin – 28,1%, and the antigen of pancreatic tissues – in 19,5%. The appearance of circulating antibodies, presumably, is the body's response to organ tissue damage. The greatest manifestation of the immunological changes observed in destructive forms of acute pancreatitis: s-DNA in 62,1% (56,6% – in dropsical form of acute pancreatitis), d-DNA – 62,1% (49,1%), n-DNA – 55,2% (49,1%), trypsin – 48,3% (39,6%), insulin – 37,9% (22,6%) and pancreatic tissue antigens – 27,6% (15,1%).

The appearance of antibodies to DNA in the literature is regarded as an indicator of autoimmune process [16, 17]. Antigenic properties in acute pancreatitis acquire structural (pancreatic tissues antigen) and

secretory (trypsin, insulin) components pancreas. In acute pancreatitis revealed distinct autoimmune reaction to structural and secretory pancreas components. It should be noted that the deoxyribonucleic acid (DNA) in a large amount is in the nuclei of pancreatic acinar cells. When released from the cell as a result of degradation, the DNA is contacted with immunocompetent cells. In this regard, antibodies to DNA (s-DNA and d-DNA) can also be regarded as a structural component of the pancreas, along with the pancreatic tissue antigen, which is specific but not pancreas.

We have noted a correlation between the presence of antibodies to endogenous antigens and a number of clinical and laboratory parameters, which were more pronounced in acute destructive pancreatitis. Detection of antibodies to DNA, tissue antigens and pancreatic trypsin was associated with an increase in general indicators of inflammatory activity (ESR and leukocytosis). The presence of antibodies to trypsin correlated with serum levels of trypsin in acute pancreatitis: the level of antibodies in the presence trypsin thereto was  $17,24 \pm 0,9$  ( $\mu\text{mol/Min.}\cdot\text{ml.}$ ), which was significantly higher ( $P < 0,05$ ) than patients who lacked the antibody –  $11,12 \pm 0,8$  ( $\mu\text{mol/Min.}\cdot\text{ml.}$ ) The level of trypsin for patients with various forms of acute pancreatitis was also dependent on the presence of antibodies to trypsin: in acute pancreatitis destructive antibodies in the presence trypsin –  $17,63 \pm 1,1$  ( $\mu\text{mol/Min.}\cdot\text{ml.}$ ), and absence of antibody to trypsin –  $13,40 \pm 0,8$  ( $\mu\text{mol/Min.}\cdot\text{ml.}$ ) with dropsical form – in the presence of antibody to trypsin –  $16,99 \pm 0,9$  ( $\mu\text{mol/Min.}\cdot\text{ml.}$ ) and the absence of antibodies to trypsin –  $9,60 \pm 0,7$  ( $\mu\text{mol/Min.}\cdot\text{ml.}$ ). Therefore, the determination of antibodies to DNA, tissue antigens of pancreatic trypsin and characterize the activity of the inflammatory process in the pancreas.

The presence of antibodies to insulin was correlated with the level of blood glucose: at acute destructive pancreatitis in the presence of antibodies to the insulin increase in blood glucose was observed in 63,6% of patients, with the absence of antibodies to insulin – significantly less ( $P < 0,05$ ) – 23,5% at dropsical form in the presence of antibodies to the insulin increase in blood glucose was observed in 41,7% of patients in the absence of antibodies to insulin in 2,4% ( $P < 0,01$ ). We suggest that insulin in acute pancreatitis becomes antigenic properties, due to the

destruction of beta cells with active inflammatory-destructive process in the pancreas that characterizes the extent and depth of the pathological changes in the body. Further, the presence of antibodies to insulin can occur picture is beta-cell insufficiency insular with clinical diabetes.

In the dynamics of antibody titers to endogenous antigens in patients with acute destructive pancreatitis in the 2nd week it was slightly higher than in the 1st week. In patients with acute pancreatitis dropsical form dynamics titers of antibodies to endogenous antigens were reversed, with the exception of pancreas tissue antigen. The gradual decline in antibody levels subside as the pathological process, probably a reflection of the protective reaction of the organism.

On the severity of antibody indirectly indicates the level of serum immunoglobulins. We investigated the level of IgA, IgG and IgM in 44 patients with acute pancreatitis. In the control group (40 healthy donors) major classes of immunoglobulins level was: IgA –  $1,67 \pm 0,06$  g/l, IgG –  $8,65 \pm 0,04$  g/l and IgM –  $1,05 \pm 0,01$  g/l. Compared with the control group of patients with acute pancreatitis was significantly increased ( $P < 0,05$ ) Contents IgM –  $1,51 \pm 0,04$  g/l and IgA –  $1,88 \pm 0,07$  g/l. Lowered ( $P < 0,01$ ) as compared with the control group the level of IgG –  $7,73 \pm 0,09$  g/l.

At the destructive forms of acute pancreatitis increased content of immunoglobulins of all classes compared to dropsical form: IgA –  $1,92 \pm 0,07$  g/l, IgG –  $8,46 \pm 0,08$  g/l and IgM –  $1,59 \pm 0,04$  g/l. In dropsical form of serum immunoglobulin content below: Ig A –  $1,85 \pm 0,07$  g/l, IgG –  $7,32 \pm 0,12$  g/l and IgM –  $1,47 \pm 0,04$  g/l. A statistically significant difference in the IgG content with destructive and dropsical forms ( $P < 0,05$ ).

A significant elevation of serum immunoglobulins was observed in seropositive patients with acute pancreatitis in relation to all studied endogenous antigens. Level of IgM was statistically significantly increased in patients with the presence of antibodies to s-DNA (respectively  $1,58 \pm 0,041$  and  $1,42 \pm 0,06$  g/l) and d-DNA (respectively  $1,59 \pm 0,05$  and  $1,43 \pm 0,03$  g/l) at a confidence ( $P < 0,05$ ), in pancreatic tissues antigens (respectively –  $1,80 \pm 0,05$  and  $1,44 \pm 0,03$  g/l), trypsin (respectively –  $1,61 \pm 0,021$  and  $1,42 \pm 0,03$  g/l) and insulin (respectively  $1,75 \pm 0,04$  and  $1,44 \pm 0,03$  g/l) at a confidence ( $P < 0,01$ ). Level of IgG was statistically significantly

increased in patients with the presence of antibodies to insulin (respectively  $8,77 \pm 0,11$  and  $7,43 \pm 0,14$  g/l) for pancreatic tissues antigens (respectively –  $8,64 \pm 0,12$  and  $7,58 \pm 0,11$  g/l) at a confidence ( $P < 0,05$ ) and of s-DNA (respectively,  $8,35 \pm 0,11$  and  $6,84 \pm 0,13$  g/l), d-DNA (respectively,  $8,30 \pm 0,12$  and  $7,11 \pm 0,14$  g/l), n-DNA (respectively –  $8,31 \pm 0,12$  and  $6,89 \pm 0,13$  g/l) and trypsin (respectively –  $8,58 \pm 0,09$  and  $6,96 \pm 0,14$  g/l) at a confidence ( $P < 0,01$ ). The level of Ig A was statistically significantly increased in patients with the presence of antibodies to DNA-n (respectively –  $1,93 \pm 0,05$  and  $1,79 \pm 0,04$  g/l).

The average level of circulating immune complexes in patients with acute pancreatitis was  $179,04 \pm 6,84$  units, which was significantly higher ( $P < 0,01$ ), than in the control group –  $94,72 \pm 3,52$  units. The level of circulating immune complexes in destructive form was higher ( $209,37 \pm 9,83$  units). Than in the dropsical form of acute pancreatitis ( $159,17 \pm 7,82$  units.). The level of circulating immune complexes was increased in patients with the presence of endogenous antibodies to all antigens except trypsin.

When comparing the frequency of the HLA antigen distribution in patients with acute pancreatitis and healthy individuals from among the alien population of Western Siberia [15, 16] in a group of patients with acute pancreatitis observed a significant increase in the frequency of determining the HLA antigens A1 ( $P < 0,01$ ), B8 ( $P < 0,001$ ), B18 ( $P < 0,05$ ), Cw1 ( $P < 0,001$ ). For antigen detection rate which was significantly increased in acute pancreatitis, the magnitude of the relative risk were as follows: A1 – 2,14; B8 – 3,66; B18 – 3,58; Sw1 – 5,93. In patients with different forms of acute pancreatitis we observed statistically significant differences, expressed in the absence of B16 antigen in acute destructive pancreatitis ( $P < 0,05$ ) and B27 antigen in the dropsical form of acute pancreatitis ( $P < 0,05$ ). HLA antigens B8 A1i associated with dysregulation between T- and B-functioning immune system, which manifests itself primarily as a defect of T-suppressors as a result of the immune response is enhanced and becomes inadequate autoimmune [14, 17]. Patients with phenotype A1, B8 in chronic pancreatitis smaller effect than all patients generally gave protease inhibitors, more – immunomodulators thymic origin enterosorption and intravenous laser irradiation of blood [14]. Sw1 antigen associated

with a low activity tripsinsvyazyvayushey alpha-2-macroglobulin, HLA B18 antigen system deficiency associated with severe and suppressor T-cell to autoserotherapy pancreatic tissue [9]. The antigen HLA B27 system is associated with the immunocomplex pathology – ankylosing spondylitis, Reiter's disease, diffuse connective tissue diseases [14, 15] and the development of pancreatitis in patients with gallstone disease [14, 18].

### Conclusion

Immune cells developing immune disorders and play an important role in the pathogenesis of acute pancreatitis and determine the severity of the disease [5, 6, 11, 10, 22]. It is shown that the assessment by APACHE II score of 16 points or more in the clinic is a predictor of excessive immune response and premature immunosuppression, and expressed local and systemic complications in acute pancreatitis [12].

Identified by us in patients with acute pancreatitis: improved circulation of autoantibodies to an endogenous antigen, serum immunoglobulins, immune complexes, combined with the presence of the phenotype antigens HLA A1, B8, B18 associating with dysregulation between the T and B-functioning immune system, which manifests itself primarily as a defect of T -suppressorov [14, 16, 17] are genetic and humoral mechanisms mediating autoimmune reactions in acute pancreatitis.

Knowledge of HLA-phenotype in patients with acute pancreatitis allows to predict the development of immune disorders affecting the outcome of the disease, and accordingly plan the use in the treatment of patients with immunosuppressive therapies and sorption.

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*Short Reports***COMPLEX CRYSTALLOSCOPIC STUDY  
OF METABOLIC REHABILITATION  
EFFECT AT RECTAL USE OF REACTIVE  
OXYGEN SPECIES**

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Based on the saliva and intestinal colon cleaning waters teziocrystalloscopic and spectrometric analysis of the 12 healthy people and 12 patients after rectal ozone detoxication, which was accomplished by colon irrigation with the ozone-contained isotonic sodium chloride solution we found out peculiarities of the free biosubstratum crystals building. Biosubstance crystallogenesis characteristics were evaluated after one procedure and the whole rectal ozonotherapy course. We disposed that one rectal ozonotherapy and the whole course changed free crystallogenesis of the saliva and intestinal colon cleaning waters in different ways.

At present time indicatory role of the crystallographic methods are actively studied. They allow monitoring patient's condition by biological fluids crystallization characteristics [1–3, 5]. As some authors think use of the crystallographic methods is very informative in human pathology diagnostics, management effectiveness estimation and pathogenesis investigation [1–5]. The importance of crystal building and initiation properties of biosubstrata include metabolic changes verification possibilities [3, 5]. In connection with it the above-mentioned methods could be applied to control systematic ozonotherapy effectiveness. Today this problem is insufficiently studied, because the informative methods of patients condition dynamics estimation according treatment are absent.

A lot of human biological substrata are studied (blood serum, saliva, urine, gastric juice, tears etc.). Tendencies for use some of biological substances (first of all blood serum) as a universal substrata for crystalloscopic analysis are wide spread [1, 5]. But maximal metabolic changes found in biofluids are anatomically or/and functionally connected with potentially disordered organ or system [3]. Estimation of the biosubstrata free and initiated crystallogenesis peculiarities is highly significant because it is informative for clinical diagnostics, and isn't studied at all. The biosubstances are excrements and colon cleaning waters (colon lavage).

**This research aim** was investigation of saliva and colon cleaning water of the healthy people and patients under rectal detoxication.

**Materials and methods of research.** We tested free crystallogenesis properties of saliva and colon cleaning waters of the 12 healthy people and 12 patients after rectal ozone detoxication, which was accomplished by colon irrigation with the ozone-contained isotonic sodium chloride solution. Control points were in 1 hour after the first and the last procedure.

The main crystalloscopic method was classic crystalloscopy [3, 4]. Results evaluation of the own crystallization was accomplished by criteria system including structure index (SI), crystallization rate (CR), facia's destruction degree (FDD) and marginal belt clearance (MB). We studied more than three micropreparation sight field.

Except visual morphometry we used spectrometric analysis of the crystals and amorphous structures formed after biological substrata dehydration. This method allowed to verificate the biological fluids morphology changes in the rectal ozonotherapy dynamics.

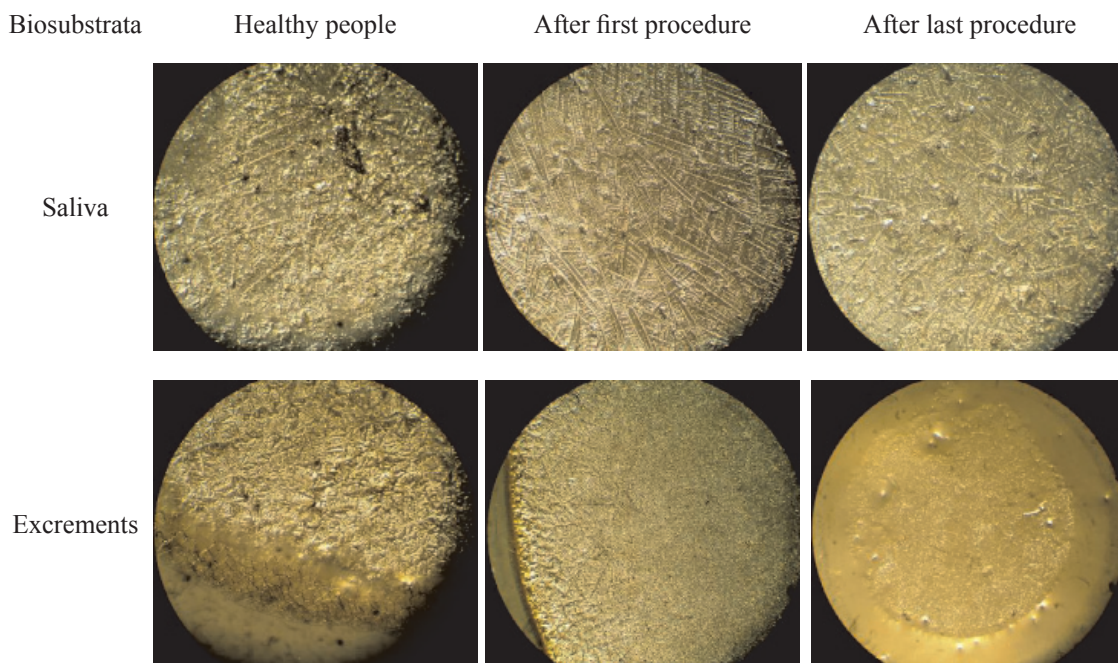
Statistic processing of the data was accomplished by Microsoft Excel 2003 spreadsheets and the programs Primer of Biostatistics Vers. 4.03. and SPSS 11.0.

**Results of research and their discussion.** By the crystallograms morphometric analysis (Figure) we determined that the first procedure of the rectal ozone-contained sodium chloride irrigation had a structurizing effect on dehydrated biofluids crystals. This was illustrated by the structure index.

At the same time we noted temperate inhibition of crystallogenesis (on crystallization rate) connected with the basic level of marginal belt diameter (MB) and facia's destruction degree growing (FDD). Similar changes were also found in colon cleaning waters but there crystallogenesis had a moderate character. It is necessary to underline that the crystal bodies were almost absent in the specimens of the control group.

The course of rectal ozonotherapy has normalized all of the estimated parameters, but facia's destruction degree of dehydrated saliva micropreparations was negative. In the excrements specimen we noted stabilization of the investigated criteria. They had an increased dynamics at last procedure (Figure).

The results of the biofluids spectrometric analysis demonstrated similar dynamics from the first to the last ozone-contained isotonic sodium chloride solution irrigations. We determined high correlation between spectrometric data and crystalloscopic estimation coefficients ( $|r| > 0,7; p < 0,05$ ).



The saliva and excrements crystalloscopic facias of the healthy people and patients under rectal irrigation of ozone-contained isotonic sodium chloride solution (x70)

### Conclusion

Biological fluids of gastrointestinal tract react actively on rectal ozone irrigations, and effects of one procedure and the whole course were different. It was determined that the course of rectal ozone detoxication had positive effect on the biosubstrata crystals building properties, and one procedure changed negatively some crystalloscopic characteristics.

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### SPECIALTIES OF CRYSTALLOGENIC PROPERTIES OF SALIVA AND BLOOD SERUM IN PATIENTS WITH THERMO-INHALATION TRAUMA

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Character of free and 0,9% sodium chloride solution initiated crystals yielding in saliva and blood serum of the 14 thermo-inhalation traumatized patients was studied. Spectrometric characteristics of the biofluids newgenied crystals at the 300–400 nm wave-lengths were estimated. We disposed the teziocrystalloscopic «pattern» of human biosubstratum for the studied pathological state.

Today crystalloscopic analysis of the dehydrated biological fluids is wide spread [1–5]. It is known that informativity of the crystalloscopic picture is determined by changes in biological substratum chemical composition and its physical properties, which are associated with patient's functional status. The advantages of this research methods group underline the importance of crystalloscopy application. At the same time the majority of approaches described in literature base on comparison of the dehydrated biological fluids samples by qualitative attributes and



on attempts of specific crystalloscopic «markers» separation of different pathological states. That is why the significant question of modern biocrystallography is the highest possible objectivity of findings [2, 5]. It should be mentioned that the most authors do not describe or analyse the process and results of yielding of crystals, except visual description [1, 3]. There is almost no information about biological fluids morphology at burn disease, and first of all at thermo-inhalation effect [4]. That is why **our research aim** was data comparison of the criterial visual morphometry for facias of saliva and blood serum at patients with thermo-inhalation trauma, and biosubstratum neogenic crystals spectrometric analysis.

**Materials and methods of research.** We studied character of free and 0,9% natrium chloride solution initiated crystals yielding in saliva and blood serum of the 14 thermo-inhalation traumatized patients. The dehydrated biological fluids micropreparations were made by classic crystalloscopy and comparative tezigraphy methods [2]. Estimation of

the crystalloscopic and tezigraphic analysis results was made by the original algorithm [2].

Situated on the object-plate samples of the dehydrated biological fluids were examined spectrometrically by the PowerWave XS device (USA), special attention was paid to the waves with the 300, 350 and 400 nm length absorption rate.

Statistic processing of the data was accomplished by Microsoft Excel 2003 spreadsheets and program systems Primer of biostatistics 4.03 и SPSS 11.0.

**Results of research and their discussion.**

Based on the morphometric analysis of the saliva and blood serum crystalloscopic and tezigraphic facias of the thermo-inhalation traumatized patients, we established that free (Fig. 1) and initiated (Fig. 2) crystallogenesis of such patients had a specific character. It should be mentioned that thermo-inhalation trauma features became apparent in micropreparations, when the characteristics of the biosubstratum samples were preserved.

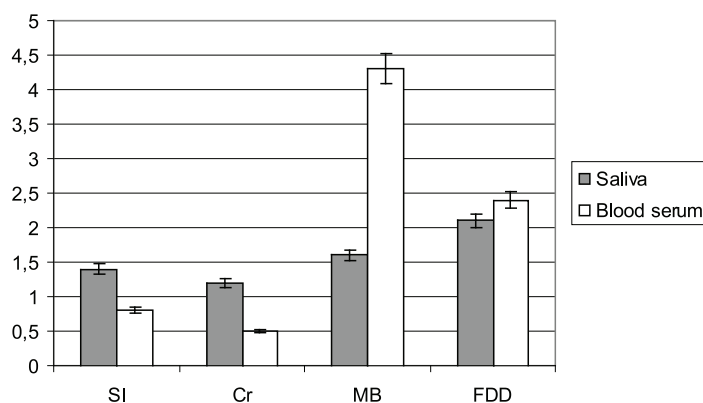


Fig. 1. Results of the saliva and blood serum facias crystalloscopic morphometry

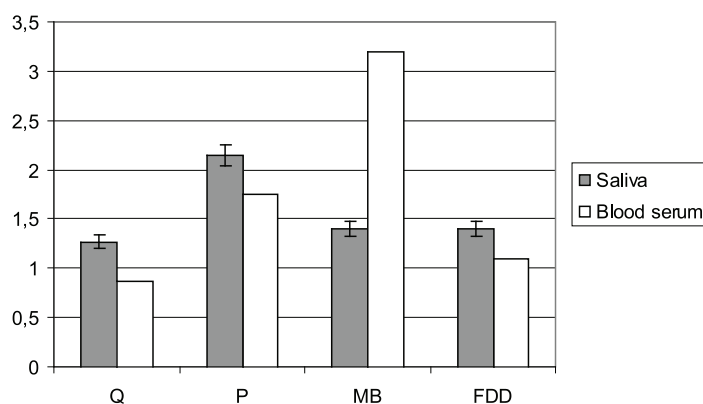


Fig. 2. Results of the saliva and blood serum facias tezigraphic morphometry (basic substance – 0,9% sodium chloride solution)

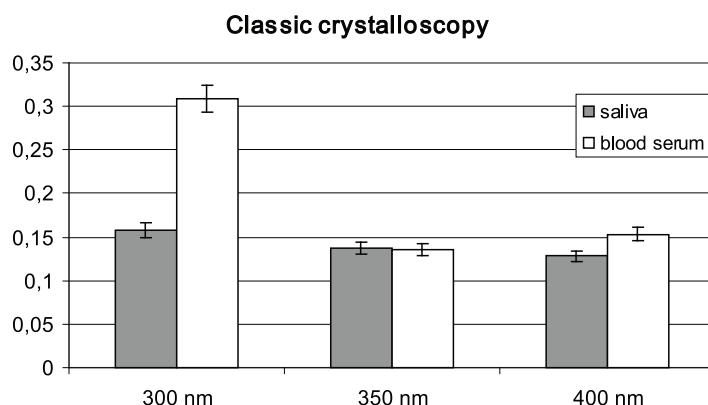


Fig. 3. Results of the saliva and blood serum facias crystalloscopic spectrometry

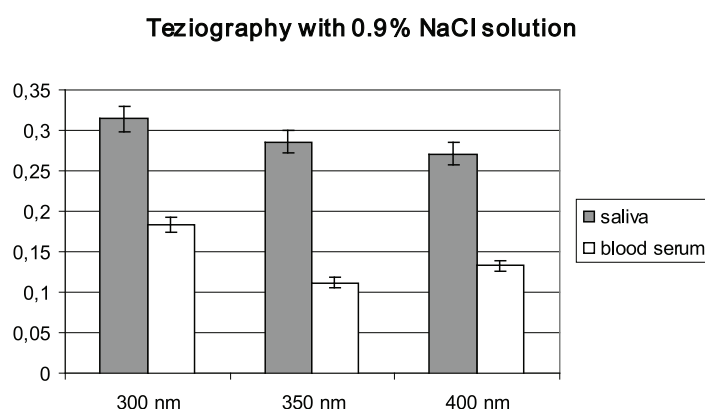


Fig. 4. Results of the saliva and blood serum facias teziographic spectrometry (basic substance – 0,9% sodium chloride solution)

Analysis of the facias spectrometric characteristics revealed some peculiarities of the biofluids crystals absorption rate at the above-mentioned wave-lengths (Fig. 3, 4). It is interesting that absorption rate differentiation was noted only at 300 nm wave-length (Fig. 3) in the samples made by classic crystalloscopy methods, whereas teziographic facias were differ in spectrometric characteristics at all of the studied wave-lengths (Fig. 4).

Revealing of the high and medium correlated connections ( $p < 0,05$ ) between crystals visual morphometry characteristics and their spectrometric parameters in the crystalloscopic test proved additionally biofluids composition changes at thermo-inhalation effect.

#### Conclusion

Considerable shifts in saliva and blood serum crystallogenic and initiating properties were re-

vealed at thermo-inhalation trauma and visualized morphometrically and spectrometrically.

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## THE RATIONAL USE OF ENERGY RESOURCES FOR CREATION THE REQUIRED MICROCLIMATE PARAMETERS IN RUSSIAN ORTHODOX TEMPLES

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The features of the establishment and maintenance of the required parameters of the microclimate in the Russian orthodox churches discusses. Constructive features of the orthodox churches of various architectural forms and styles, which affect on design of natural ventilation systems is considered. The features of experimental studies in the wind tunnel which conducted to find the aerodynamic coefficients are described. The mathematical relationships to determine the consumption of candles, which obtained on the basis of statistical data and experimental studies, is considered. Recommendations for the design of heating systems in the prayer halls of the temples are given.

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**Keywords:** orthodox temples, microclimate, aerodynamics, aeration, consumption of candles

Considering the various orthodox temples, located on the territory of the Russian Federation, it is possible to trace the history of Russian architecture, long more than a thousand years. The parallel development of the stone construction and wooden architecture played an important role. Many elements, which has the first embodiment in the wood, subsequently used in the stone construction. Of course, at the same time remained a sacred meaning inherent in each element, both in the external architecture (the number of domes, form of dome, etc.), as well as in the interiors (filling the iconostasis, burning candles, etc.). Each temple is considered as a unique structure, and, in solving various engineering tasks, each of them requires an individual approach.

Currently, this issue is very relevant, since many of temples are restored from the ruins or buildings, which use for other purposes (workshops, warehouses) that have become established as a result of the ravages of the Soviet regime. Recovery of each temple is a complex and individual task. The department of heat and gas supply of Nizhny Novgorod State University of Architecture and Civil Engineering for many years conducted research and practical activities in the field of creation the required parameters of the microclimate in the orthodox temples.

In solving such problems in the first all pay attention to the architectural and design features of the temple: tent temple, in the form of "ship", cross-domed, tiered temple, etc. And here the important role played by the history of the construction of the temple, for example, in Nizhny Novgorod, a temple built by the order of the merchant Strogonov built in a unique style, which subsequently received the name "Strogonovskoe baroque (baroque of Strogonov)". The architecture of the temple is important for

the experimental determination of aerodynamic coefficients – the dimensionless variables, showing what proportion of dynamic pressure becomes static pressure. Knowing the value of aerodynamic coefficients can calculate the area of natural ventilation systems in the prayer hall.

Natural ventilation (aeration) in the temples has a number of advantages compared with mechanical: does not consume electrical energy, much cheaper, relatively low-cost installation, does not violate the interior of the church, has the property of self-regulation that can reduce the thermal load on the heating system. But this calculation of aeration system requires consideration a number of factors that may generally be determined using experimental studies. Similar experiments are conducted in a wind tunnel, and the model of temple itself is drained by pipes in places of possible location of the intake and exhaust transoms. The most effective it is considered the installation of air-supply transoms in the lower tier of the window openings of the prayer hall, and the transom exhaust set at the top of the window openings of the drum over the prayer hall [1, 2, 3, 4]. However, this is only possible if the vault of the prayer hall is not separated from the drum by a partition.

For all of five domes have access in the Rozhdestvenskaja (Stroganovskaja) Church (str. Rozhdestvenskaja, Nizhny Novgorod), which gives a large variation in the placement of the exhaust transoms in the temple, in the Krestovozdvizhenskij cathedral (st. Okskiy s'ezd, Nizhny Novgorod) have access just to central dome and in the church of Zhen-Mironosic (str. Dobrolyubov, Nizhny Novgorod) vault fully hardwired (in this case, the exhaust transoms can only use a portion of the upper tier of window openings of the prayer hall).

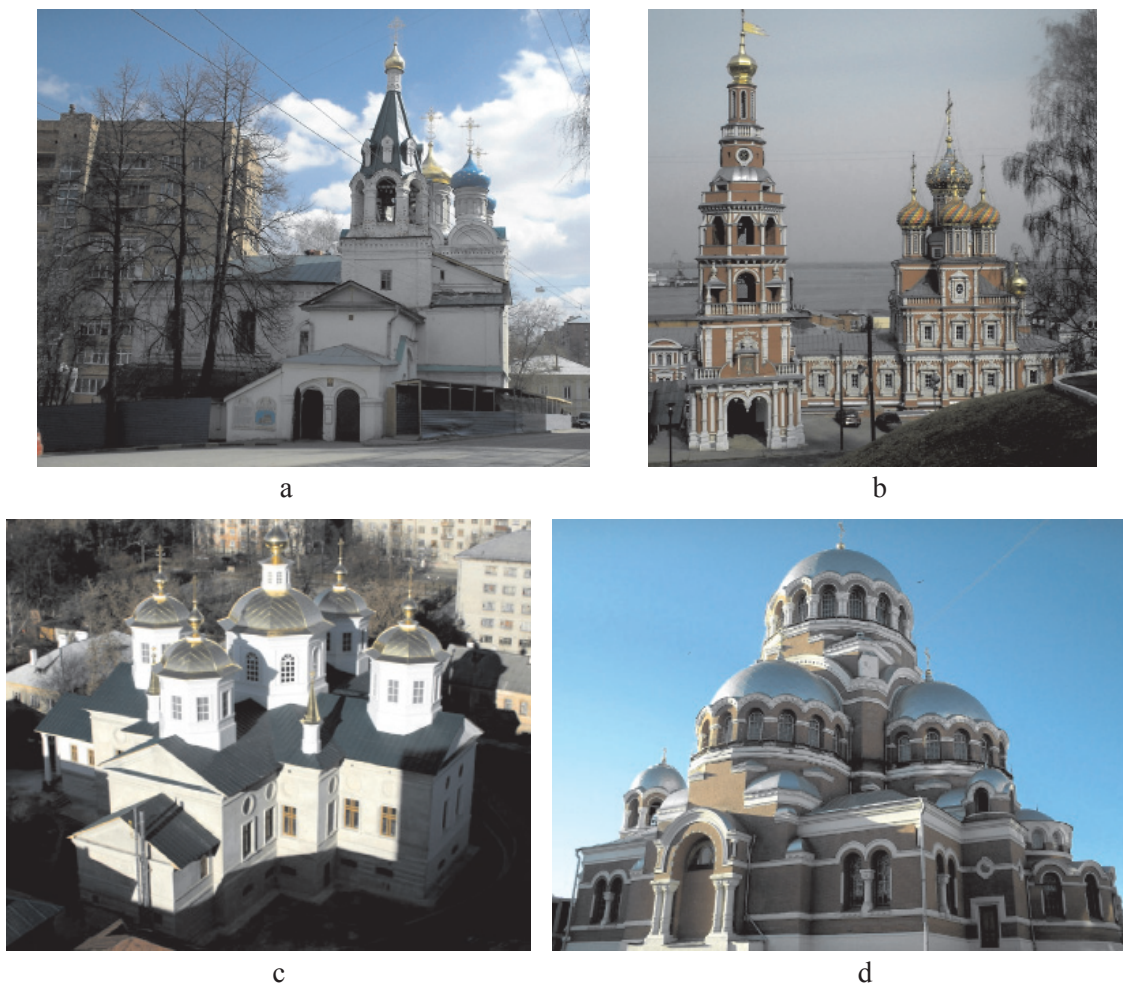


Fig. 1. Explored temples:  
 a – The Church of Zhen-Mironosic; b – Rozhdestvenskaja church;  
 c – Krestovozdvizhenskij cathedral; d – Spasopreobrazheniskij cathedral

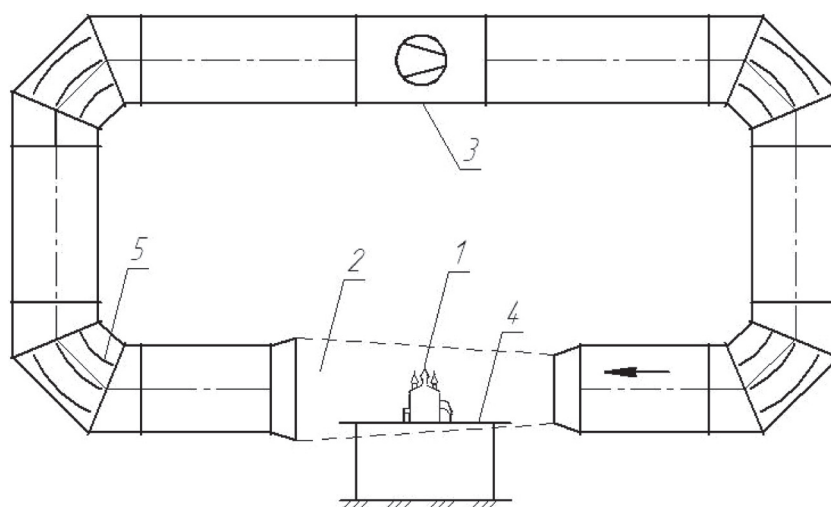


Fig. 2. Experimental setup:  
 1 – the investigated model of the object; 2 – the working area of a wind tunnel;  
 3 – axial fan; 4 – stand for model building; 5 – guide ribs

Models of all these above mentioned temples and the Spasopreobrazheniskij Cathedral (Sormovo, Nizhny Novgorod) were tested in a closed subsonic wind tunnel (Fig. 2) to obtain a result of the values of aerodynamic coefficients fields. The measurements were made for each point for the eight directions of airflow: north, northeast, east, southeast, south, southwest, west and northwest (Fig. 3) [4].

Equally important in the design of natural ventilation is the study of the internal aerodynamics of the temple. In addition to the heating systems the large amount of heat released from the candles, lamps and parishioners. Moreover, the magnitude of heat from the candles can be comparable to the capacity of the heating system.

To account for the consumption of candles were conducted statistical and experimental studies in various churches in Nizhny Novgorod in the different periods of the year, including during the patronal feasts, when in temples is marked the maximum quantity of the parishioners.

In the church of the Archangel Michael (in the territory of Nizhny Novgorod Kremlin) located 170 nests under candles in sconces and consumption of candles on the average is 0,78 kg/h.

In the Zhen-Mironosic church (str. Dobrolyubova) located 448 nests under the candles, the average consumption – 2,15 kg/h.

In the Uspenija Bozhiej Materi church (lane Krutoj) located 438 nests under the candles, the average consumption – 1,58 kg/h.

In the Prepodobnogo Sergija Radonezhskogo church (str. Sergievskaja) located 496 nests under the candles, the average consumption – 2,38 kg/h.

In the Voznesenija Gospodnja church (str. Il'inskaja) located 313 nests under the candles, the average consumption – 1,44 kg/h.

In the Vsemilostivejshego Spasa church (str. Maksima Gor'kogo) located 735 nests under the candles, the average consumption – 3,38 kg/h.

In the Krestovozdvizhenskij cathedral (st. Okskiy s'ezd) located 526 nests under the candles, the average consumption – 2,21 kg/h.

In churches of Zhen-Mironosic and Uspenija Bozhiej Materi in spite of a comparable number of nests under candles, the average candles consumptions differs significantly (in the first temple is 26% more). Both these temples belong to the type “ship” [5, 6] and have separated vault of the prayer hall from drums, and as a result, through the drums of the temple

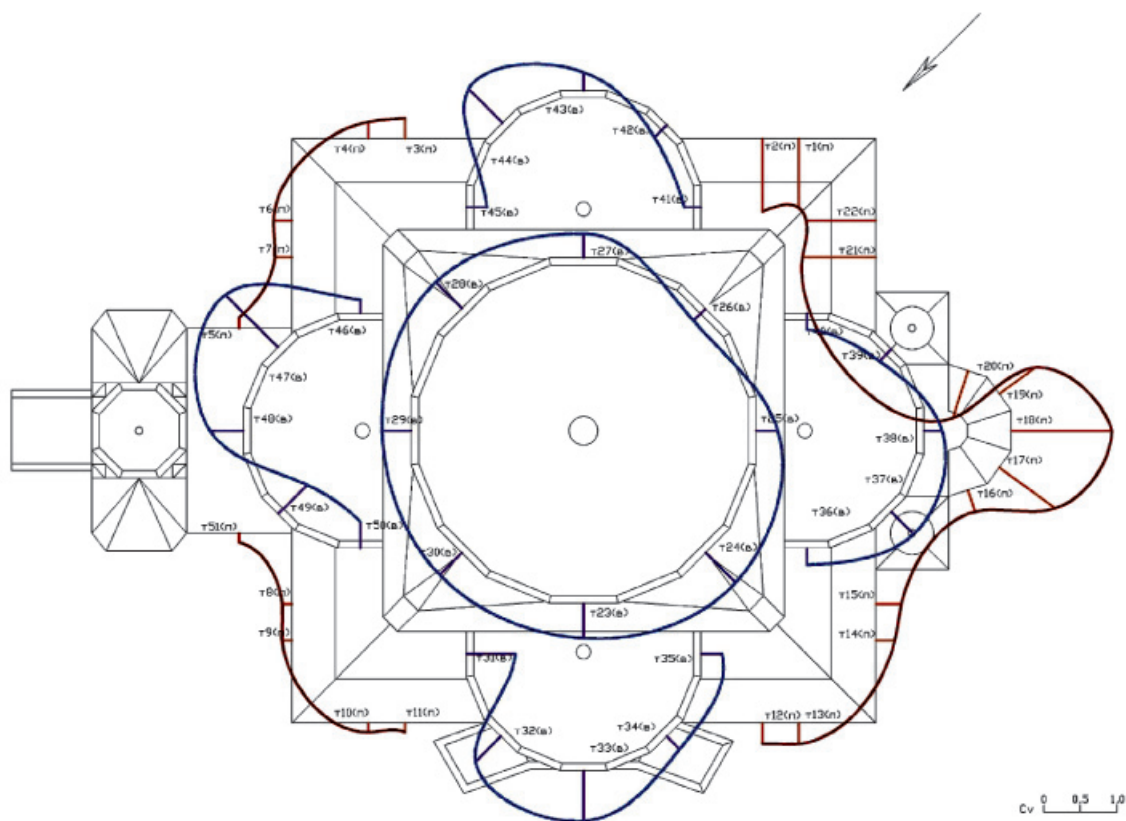


Fig. 3. The example of values of aerodynamic coefficient fields for the Spasopreobrazheniskij cathedral at the northeast wind direction

is not possible to carry out natural ventilation. However, the church of Zhen-Mironosic is a combined summer and winter of the church, so that in terms of the prayer hall has a half T-shaped without walls, while in the church of Uspenija Bozhiej Materi – T-shaped.

At 50% filling parishioners of the prayer hall of an Orthodox church, according to statistics there is full occupancy candles in sconces nests. When the maximum filling parishioners of the prayer hall (during the main patronal feasts) in addition to the candles in sconces worshipers burned candles in their hands, but usually, their number does not exceed 30%.

Form coefficient, which varies from 0,75 to 1,13 – an empirical value has been introduced by us to take into account the architectural and design features of temple.

The following mathematical relationships have been formulated based on our experimental studies and written in a general form:

$$G_c^{\min} = \frac{0,1 \cdot g_c \cdot n_c \cdot K_f}{1000}; \quad (1)$$

$$G_c^{\text{mid}} = \frac{g_c \cdot n_c \cdot K_f}{1000}; \quad (2)$$

$$G_c^{\max} = \frac{g_c (n_c + 0,3 n_p) \cdot K_f}{1000}, \quad (3)$$

where  $G_c^{\min}$ ,  $G_c^{\text{mid}}$ ,  $G_c^{\max}$  – consumption of candles kilogram per hour, respectively, for the minimum (10%), moderate (50%) and maximum (100%) of filling of the prayer hall parishioners;  $n_c$  – the total number of nests under the candles in the temple, pcs;  $n_p$  – the maximum number of parishioners, person;  $K_f$  – form coefficient;  $g_s$  – the consumption of candles from one socket, gram per hour (ranging from 3 to 5 gram per hour depending on the season of year).

Theoretical and experimental research will allow conducting a more accurate calculation of the system of natural ventilation in the prayer hall. As aeration systems do not consume electricity, liberated electrical power, calculated on the mechanical system can be directed to drying the basement structure of the temple (in the heat gun), since over moistening of basement of the building cause additional heat losses through the zones of regular (seasonal) temperature changes.

Due to the drying of over moistening basement structures providing the required vapor permeability protecting the walls from precipitation and to create the required meteorological conditions of engineering systems can achieve savings of thermal energy in the temples of the order 7–15% of total heat loss of the building.

A separate issue is the heating of the temple. Completely eliminate the release of soot from the combustion of candles is not possible, therefore, to reduce the deposition rate of the polarized soot on walling structure can be installed for heating churches radiators (with heat transfer about 50% by convection and approximately 50% by radiation) or registers of smooth pipes to the same redistribution of species heat. Set in the convectors for heating churches, which have about 75% of heat transfer by convection and approximately 25% – radiation should be after the thermal and aerodynamic research. Above the convector creates a powerful upward convection current which lead to intensive deposition of soot on the envelope surface above the heater. For the churches in the region, with an estimated outdoor temperature  $t_{\text{ext}} \leq -20^\circ\text{C}$ , depending on their volume-planning and design solutions should be designed or radiator, or combined with radiant panel heating and air heating, or just air heating system.

A very controversial decision is the installation of under floor heating, as the convective flows generated over the heated surface of the floor in the temple, a negative impact on climate parameters, on people and on the stability of the candles burning in the cold season.

These tips may help in the work to achieve optimal economic effect and save interior of the church, protecting it from the negative effects described above.

More specific recommendations for each temple are selected individually, depending on the climatic influences, structural, architectural and stylistic peculiarities and other factors on the basis of the surveys, calculations or experimental studies.

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## A STUDY OF THE POWER CONTACTS IN MAGNETIC LIQUEFIED LAYER OF FERRO-IMPURITIES IN THE COOLANT IN THE WORKING VOLUME OF ELECTROMAGNETIC DENSITOMETERS (EPL)

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In article results of research of power contacts in magnetic liquefied layer of ferro-impurities in the coolant in the working volume of electromagnetic densitometers (EPL). Studies were conducted on the basis of the dipole model. Identified the main parameters that affect the magnitude of the force interaction between metal impurities in the lubricating-cooling liquids (coolant) under the action of a constant sign and is controlled by the magnitude of the electromagnetic field. A method for calculation of magnetic fields in the working volume of the EPL. To build the magnetic field of the coil with the current in the presence of the cylindrical rotor is used the method of integral equations. The method is based on the introduction of secondary sources and consists of reducing the problem to integral equations with their numerical solution. The conducted research allow for the design of high-speed instruments for the qualitative Express analysis of contamination of the coolant.

**Keywords:** electromagnetic densitometer, ferromagnetic impurities, rapid analysis

A lubricating and cooling technological environment is an essential element of technological process of material's treatment in repair shops in the agro-industrial complex (AIC). The processes of turning, milling, drilling, grinding etc. are characterized by high static and dynamic loads, high temperatures and mechanical effects of treated material on a cutting instrument.

The function of lubricating and cooling technological environment reducing the temperature, power treatment parameters and instrument wear. The development of environmentally friendly resource systems of using of lubricating and cooling technological environment in repair productions of AIC requires a solution of the questions connected with improving the system of cleaning of them and a development of science-based methods and devices diagnosing a quality of waste technological environment in repeated cycles of operation [9, 10]. A changing of dispersed state of lubricating and cooling technological environment in the process of exploitation leads deterioration of functional and performance properties of it. The exceeding a standardized concentration of trace metals that inevitably presents in lubricating and cooling technological environment after cleaning violates technological options and leads to premature wear of an equipment.

Meanwhile the existing practice of using of lubricating and cooling technological environment at the enterprises doesn't imply an excessively attentive attitude to the diagnostics of quality on the secondary use. The known methods and devices determining trace metals in lubricating oils doesn't provide an express and qualitative analysis in closed training sys-

tems of lubricating and cooling technological environment.

**The objective of the work:** investigation of the power contacts in magnetic liquefied layer of ferromagnetic impurities lubricating and cooling technological environment in the working volume of density electromagnetic (EPL).

**The material and methods of the investigation: the subject of this study** is power interaction in the magnetic liquefied layer of ferromagnetic impurities determining the time of «ran out» in an instrument for conducting of express diagnostics of contamination of technological environment.

### The results of the investigation and discussion about them

The operating principle of the electromagnetic densitometer [7, 12] is based method of forming a bonding force of ferromagnetic powder in magnetic liquefied layer under the influence of the electromagnetic field with a constant sign and a capacity to be adjusted largest [1, 4, 5, 6] and with relative displacement of surfaces of working volume of the instrument [2, 3, 11] (Fig. 1).

The concept design for the construction of the magnetic field of the diagnostic device shown in Fig. 2.

The integral equation for determining the unknown current sheet has the form [8]

$$\sigma(z) = \frac{1}{2\pi\mu + \mu_0} [\mu - \mu_0] [B_z^*(r_0, z) + B_z^{**}(r_0, z)], \quad (1)$$

where  $\mu, \mu_0$  – respectively the magnetic permeability of ferromagnetic elements an working air gap;  $B_z^*, B_z^{**}$  – the projection of the magnetic induction vector on the axis Z (axis aligned with the axis of the device) respectively the current layer and multi-layer coil with current.

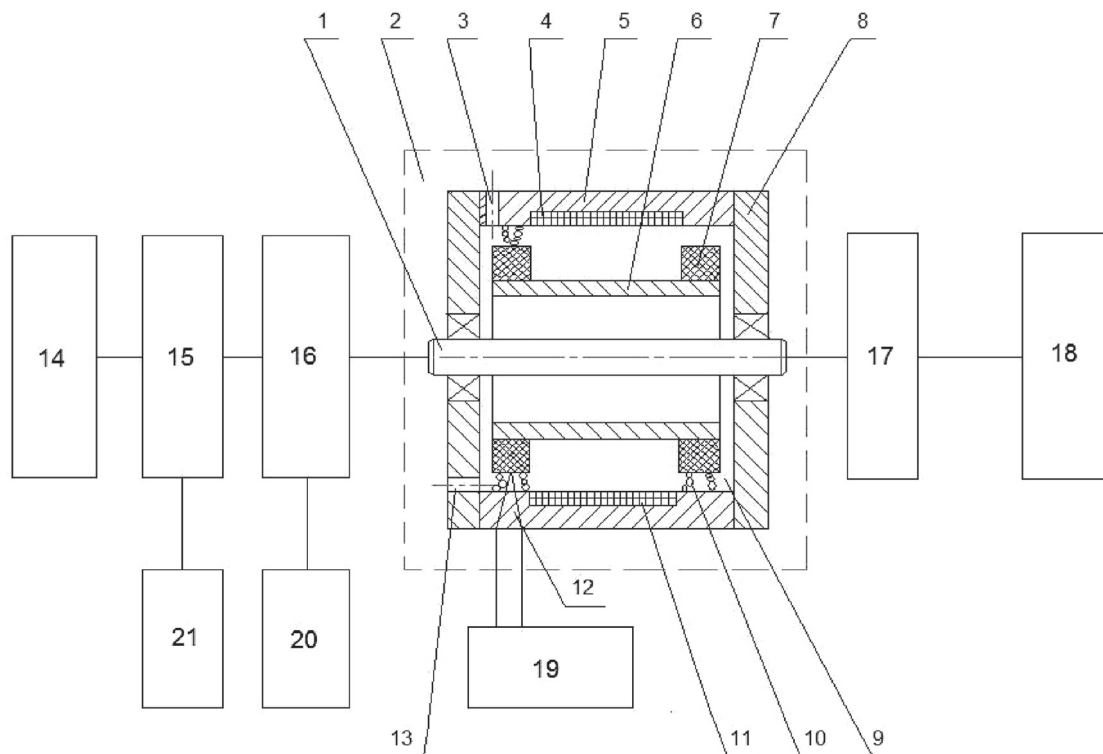


Fig. 1. The concept design of the diagnostic device:

1 – shaft; 2 – sensor; 3 – hole; 4 – control winding; 5 – fixed outer cylinder; 6 – movable outer cylinder; 7 – fins of cylinder; 8 – end shields; 9 – working volume; 10 – ferromagnetic impurities; 11 – annular groove; 12 – temperature sensor; 13 – drain hole; 14 – gear; 16 – connecting device; 17 – disk; 18 – flywheel; 19 – inductor; 20 – stopwatch fixing gear time from tripping until the complete cessation of rotation; 21 – indicator

The component  $B_z^*$  of the magnetic field in the gap defined by the formula

$$B_z^*(r_0, z) = \mu_0 r_0 \int_{-\alpha}^{\alpha} \int_0^{2\pi} \sigma(z_Q) \cos \varphi \left\{ \frac{1}{r_0 \sqrt{2r_0^2 (1 - \cos \varphi) + (z - z_Q)^2}} - \frac{r_0 (1 - \cos \varphi)}{[2r_0^2 (1 - \cos \varphi) + (z - z_Q)^2]^{3/2}} \right\} d\varphi dz_Q. \quad (2)$$

Designating the distance to any point of the working gap through  $Q_1^*$  и  $Q_2^*$ ,

$$Q_1^* = \sqrt{r_0^2 - 2r_0 r_1 \cos \varphi + r_1^2 + (z - z_Q)^2}; \quad (3)$$

$$Q_2^* = \sqrt{2r_0^2 (1 - \cos \varphi) + (z - z_Q)^2}, \quad (4)$$



the formula for determining the induction  $B^{**}$  takes the form

$$B^{**}(r_0, z) = \frac{\mu_0 IW}{2b(r_0 - r_1)} \int_{-b}^b \int_0^{2\pi} \left\{ (1 + \cos 2\varphi) \ln \frac{Q_2^* + r_0 (1 + \cos \varphi)}{Q_1^* + r_1 - r_0 \cos \varphi} + \frac{Q_2^* - Q_1^*}{r_0} \cos \varphi - \right. \\ \left. - \left\{ r_0^2 (r_0 Q_1^* - r_1 Q_2^*) \cos 4\varphi - r_0 (Q_1^* - Q_2^*) [r_0^2 + (z - z_Q)] \cos 3\varphi - 2(z - z_Q)^2 \times \right. \right. \\ \left. \left. \times (r_0 Q_1^* - r_1 Q_2^*) \cos 2\varphi + r_0 [r_0^2 + (z - z_Q)^2] (Q_1^* - Q_2^*) \cos \varphi - \right. \right. \\ \left. \left. - [r_0^2 + 2(z - z_Q)^2] (r_0 Q_1^* - r_1 Q_2^*) \right\} \frac{1}{2Q_1^* Q_2^* [r_0^2 (\cos 2\varphi - 1) + 2(z - z_Q)^2]} \right\} d\varphi dz_Q. \quad (5)$$

The magnetic field at any point in the working volume is calculated by formulas

$$B_r(r, z) = -\mu_0 r_0 \int_{-\alpha}^{\alpha} \int_0^{2\pi} \frac{\sigma(z_Q)(z - z_Q) \cos \varphi}{[r^2 - 2rr_0 \cos \varphi + r_0^2 + (z - z_Q)^2]^{3/2}} + \frac{\mu_0 IW}{2b(r_0 - r_1)} \times \\ \times \int_{-b}^b \int_0^{2\pi} \left\{ \frac{(z - z_Q)}{r^2 \sin^2 \varphi + (z - z_Q)^2} \left[ \frac{1}{Q_1^*} (-rr_1 \cos \varphi + r^2 + (z - z_Q)^2) - \right. \right. \\ \left. \left. - \frac{1}{Q_2^*} (-rr_0 \cos \varphi + r^2 + (z - z_Q)^2) \right] \right\} \cos \varphi d\varphi dz_Q; \quad (6)$$

$$B_z(r_1, z) = \frac{\mu_0 IW}{2b(r_0 - r_1)} \int_{-b}^b \int_0^{2\pi} \left\{ (1 + \cos 2\varphi) \ln \frac{Q_2^* + r_0 - r \cos \varphi}{Q_1^* + r_1 - r \cos \varphi} + \frac{Q_2^* - Q_1^*}{r} \cos \varphi - \right. \\ \left. - \left\{ r^2 (r_0 Q_1^* - r_1 Q_2^*) \cos 4\varphi - r (Q_1^* - Q_2^*) [r^2 + (z - z_Q)] \cos 3\varphi - 2(z - z_Q)^2 \times \right. \right. \\ \left. \left. \times (r_0 Q_1^* - r_1 Q_2^*) \cos 2\varphi + r [r^2 + (z - z_Q)^2] (Q_1^* - Q_2^*) \cos \varphi - \right. \right. \\ \left. \left. - [r^2 + (z - z_Q)^2] (r_0 Q_1^* - r_1 Q_2^*) \right\} \frac{1}{2Q_1^* Q_2^* [r^2 (\cos 2\varphi - 1) + 2(z - z_Q)^2]} \right\} d\varphi dz_Q; \quad (7)$$

$$B(r, z) = B_r^2(r, z) + B_z^2(r, z). \quad (8)$$

The magnetic field strength is determined from the expression

$$H(r, z) = \frac{1}{\mu_0} B(r, z). \quad (9)$$

According to the research the force interaction between particles Metal impurities in the lubricating and cooling technological environment in a homogeneous magnetic field is

$$Fr = \frac{1}{2} \frac{\mu - 1}{\mu + 2} R_0^3 \frac{\partial H^2}{\partial r} \Big|_{r=2R_0}; \\ Fr = -\frac{3}{256} H_0^2 R_0^2 \frac{(\mu - 1)^2}{(\mu + 2)^3} [(13\mu + 11) + 9(3\mu + 5)\cos 2\nu]. \quad (10)$$

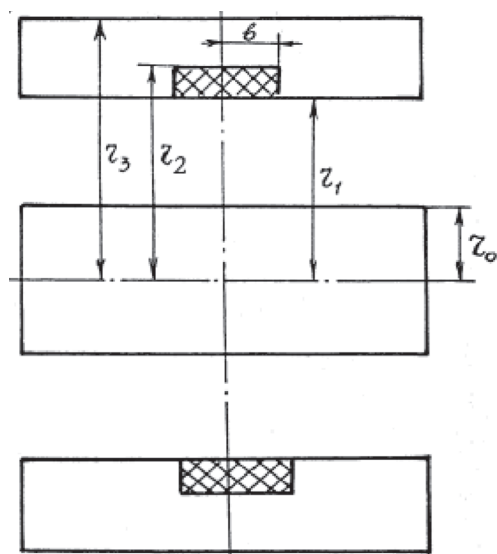


Fig. 2. Scheme to construct the magnetic field in the working volume of the diagnostic device:  
 $r_0$  – rotor radius of diagnostic devices;  
 $r_1$  – the radius of the working volume;  
 $r_2$  – the radius of the control winding;  
 $r_3$  – the radius of the body;  
 $2b$  – the width of the groove under the control winding

The moment of force field interaction with the system is defined by two elements

$$M_U = \frac{1}{2} \frac{\mu - 1}{\mu + 2} R_0^3 \left. \frac{\partial H^2}{\partial U} \right|_{r = 2R_0};$$

$$M_U = -\frac{3}{128} H_0^2 R_0^2 \frac{(\mu - 1)^2}{(\mu + 2)^3} (17\mu + 31) \sin 2\nu. \quad (11)$$

Analysis formula shows that this force is proportional to the square of the unperturbed magnetic field and the square of the radius of the elements. The angle is the angle of the structure group of ferromagnetic elements impurities strain and the value of it determining the power of interaction between this elements describes the process of organizing and fracture of structural combinations. At  $\nu = 0$

$$Fr(0) = -\frac{3}{32} H_0^2 R_0^2 \frac{(\mu - 1)^2}{(\mu + 2)^3} (5\mu + 7). \quad (12)$$

The minus sign before the formula indicates that between the ferromagnetic el-

ements of impurities occurs attraction. In this case organized stable combination of these structural elements is carried out and their interaction force between themselves and surfaces limiting the working gap with maximum intensity.

By moving the surfaces relative to each other there is a structural deformity group and the angle  $\nu$  is growing that causes a decrease in the force of attraction between the balls. Upon reaching the critical  $\nu_{KP}$  deformation angle of the interaction force vanishes.

The angle  $\nu_{KP}$  satisfies the following equation

$$(13\mu + 11) + 9(3\mu + 5) \cos 2\nu_{KP} = 0. \quad (13)$$

Thence the critical angle at which the attraction of ferromagnetic elements replaced by their repulsion is

$$\nu_{KP} = \pm \frac{1}{2} \left( \pi - \arccos \frac{13\mu + 11}{9(3\mu + 5)} \right). \quad (14)$$

During the deformation of the structure group, when the critical  $\nu_{KP}$  angle is reached the chain of ferromagnetic bodies collapses.

At  $\nu = \pm\pi/2$  th power of the interaction is determined by the expression

$$Fr\left(\pm\frac{\pi}{2}\right) = \frac{3}{128} H_0^2 R_0^2 \frac{(\mu - 1)^2}{(\mu + 2)^3} (7\mu + 17). \quad (15)$$

Ferromagnetic elements pushing each other organize “sliding layer”.

### Conclusion

On the basis of the research identified key parameters affecting on the amount of force interaction between metal impurities coolants under the forces of the electromagnetic field with a constant sign and a capacity to be adjusted largest. The technique of building a magnetic field in the working volume of the EPL provided followed by determination of the value of the contacts in magnetic liquified layer of ferromagnetic impurities. The studies allow to design high-speed devices for rapid analysis of qualitative coolant contamination.

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## METHOD OF ROUTING VARIABLE PITCH HELICAL SURFACE AND CONSTANT RADIUS PROFILE

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Known methods for producing a variable pitch screw surfaces are characterized by poor quality of the machined surface due to the low stiffness of the kinematic chain of the lead screw table to spindle, the complexity of adjusting to a given law of variation of the helical pitch of the surface. In this paper we solve the problem for the milling helical grooves with any law, changing the pitch.

**Keywords:** milling helical surfaces, variable pitch helix

In the context of large-scale and mass production is considered to be the most effective method of shaping flutes plastic deformation (hot pressing). This method – hot pressing is most effective, there is formed at the same time cutting the tail and part of the tool with minimal allowance for subsequent machining. methods for producing helical flutes by plastic deformation make it possible to produce flutes only with a constant angle of inclination of the helix. As methods of plastic deformation processes are accompanied by considerable heat, which can lead to a change in strength.

Getting flutes with variable helix angle of inclination, perhaps only by removing material. Consideration receiving flutes of twist drills to start the grinding process. Grinding is a process in which helical chip flutes formed in a workpiece of high speed steel or cemented carbide. The main advantages of the grinding process is that the geometric parameters of the flutes produced high precision and high quality work sur-

faces, as well as reducing manufacturing cycle of the tool. Maximum performance is achieved when grinding grooves by deep grinding. This method is compared with a multi-pass grinding performance advantage by grinding a groove in one pass. However, when grinding grooves increasing energy costs, there is difficulty tungsten recycling swarf, which mixes with the products of the grinding wheel wear (Fig. 1).

In terms of versatility obtain particle flutes used methods based on the removal of material (milling), this can be explained by the fact that the milling (Fig. 2) may simply change the geometry of the drill, the cross-sectional characteristics flute, core diameter, angle tilt flutes –  $w$ , the amount of back downward, the central angle that determines the width of the groove, which in turn makes it possible to, significant geometric parameters of twist drills, depending on the treated and the treatment material, cutting Regis-atoms, as well as take into account the stiffness and strength of the cutting tool.

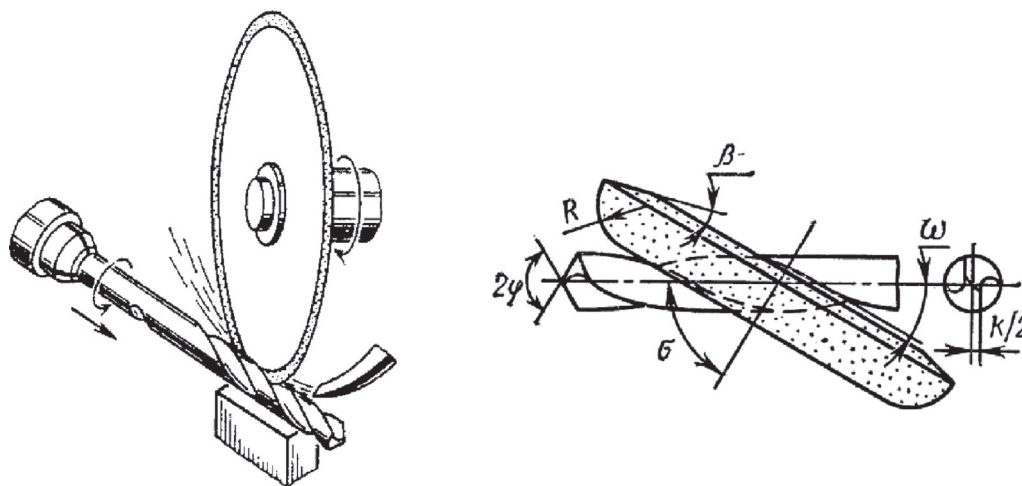


Fig. 1. Grinding helical flutes

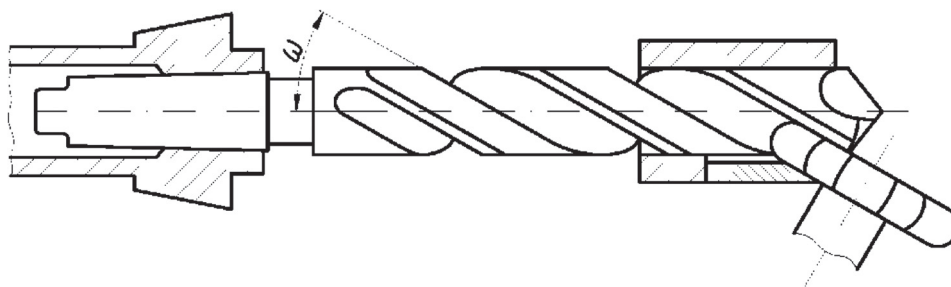


Fig. 2. Milling helical flutes

There are several inventions which provides some methods for producing the helical chip flutes. For example, in [1] describes a method for the formation of helical flutes variable pitch on bodies of revolution using the tool heads. Tool heads are on the spindle with parallel axes. Bits perform main rotational cutting motion, and then cut into the workpiece, then consistently performed four movements: billet rotation, longitudinal movement of the workpiece or tool, moving the tool along the axis of the coordinate system, tool heads rotate about an axis which is compensated-siruyut change the helix angle of inclination.

The invention is proposed to handle Neff spiral groove cutters. The essence of this method consists in the following, the workpiece is fixed in a special holder, and then draw in non-rotating center of the tool is based on a mandrel in a support angle  $\omega$  to the axis of the workpiece. Imparting rotational movement between tool and workpiece while supplying step caliber  $t$ , strand form helical groove helix angle which is  $\omega$ . In operation [2] proposed a method for obtaining helical surfaces with a predetermined inclination angle of helical flutes and the profile of a circular arc rotating tool. In [3] the method of forming the helical flutes of constant pitch in parts with a non-cylindrical core. The blank report helical movement, and the tool – the movement of rotation, at the same time carrying out its withdrawal from the axis of the workpiece. The above methods for producing helical surfaces are characterized by poor quality of the machined surface due to the low rigidity of the kinematic chain and the complexity of the adjustment to a given law of variation of the helical surface step.

For cutting spiral grooves is supposed to use universal milling machines and modernized universal dividing head. The machine must be able to turn the table and the longitudinal axis of the slider supply (trunk) with

the spindle. The most suitable for this purpose are tool machines with optional rotary table, for example, a series of machines WF1, WF2, WF3, WF4 company Khuth.

Upgrading universal dividing head is to apply additional kinematic chains to create additional torque movement workpiece at a variable rate [4].

The implementation of this scheme involves the use of dividing head with additional devices and tailstock. The workpiece is fixed in the chuck dividing head and tailstock center is urged. Table pre-rotated with the rotary plate at an angle lifting screw groove corresponding to the largest step:

$$\lambda = \arctg\left(\frac{t_{\max}}{\pi D}\right), \quad (1)$$

where  $t_{\max}$  – highest pitch of the helical groove;  $D$  – workpiece diameter.

The table with the workpiece makes uniform translational movement along the axis of the workpiece at a speed –  $S_1$  from the machine drive. From the additional rotation of the shaft of the machine drive is transmitted to the guitar interchangeable gears with a gear ratio –  $i_1$ , which is set at the initial value of the pitch helical groove by the following relationship:

$$t_0 \text{ mm move the table}$$

with the workpiece  $\rightarrow 1$  workpiece turnover

Thus, a uniform rotation of the workpiece component –  $n$ .

To get a variable pitch helical groove on the uniform rotation of the workpiece is superimposed alternating rotation, providing a step increase  $\Delta t_i$  helical groove compared with the initial value  $t_0$ :

$$\Delta t_i = t_i - t_0, \quad (2)$$

where  $t_i$  – the current value step helical groove.

For alternating rotational movement of the workpiece with an additional shaft through

a guitar replacement wheels is transmitted to the cam. Profile of the cam is constructed with a view to ensuring a predetermined law of variation of pitch helical groove [5]. Gear ratio –  $i_k$  guitar changeable gears configured so that when the workpiece is moved to its full length of thread helical groove –  $L$  cam rotates  $\Theta_p$  its working profile:

$$L \text{ mm table travel} \rightarrow \frac{\Theta_p}{360} \text{ cam turnover,}$$

where  $\Theta_p$  – working angle in degrees of cam profile.

Rack and pinion mechanism converts the translational movement of the cam follower mechanism into a rotational movement of the gear. From the rack and pinion mechanism is transmitted to the rotation power that increases the torque value to ensure sufficient force during cutting. From steering rotation is transmitted to the guitar interchangeable gears with gear ratio  $i_v$ .

The guitar is used for correcting the increment step size and is configured so that when you move the pusher to the radius difference  $\Delta r$  operating cam site provides a full step increments  $\Delta t$  the entire length of cutting portion of the helix. The number of revolutions of the workpiece required for the implementation of this increment  $\frac{\Delta t}{L}$ . The consistency condition:

$$\frac{\Delta r}{\pi \cdot m \cdot z} \text{ rev gear} \rightarrow \frac{\Delta t}{L} \text{ workpiece speed.}$$

Summation of the rotation by the two branches of the kinematic chain is made on the mechanism of differential. Uniform rotation comes from the guitar to the central driving wheel differential mechanism. Variable speed comes from the guitar to the carrier of the differential mechanism. The total rotation is removed from the driven gear and enters the dividing head mechanism, which is fixed to the workpiece spindle.

Thus, rotation is performed alternating the total workpiece, which in accordance with a uniform movement of the workpiece along its axis of helical cutting grooves provides variable pitch.

For carrying out the method is also applicable conical cutter, which is mounted on the mandrel. The mandrel is installed in the spindle slide and is supported by an earring [6]. Bevel cutter receives rotation at –  $n_p$ .

To ensure a gradual increase in the radius of the profile helical groove, conical mill together with the slider performs feed motion –  $S_f$  along

its axis. Feed rate –  $S_f$  is selected so that during the movement of the workpiece along its axis by a length section of the helical groove –  $L$ , Hiller moved along its axis by the length of the working area –  $L_f$

$$S_f = \frac{L_f}{L} \cdot S_1. \quad (3)$$

To implement this method, you must properly shaped cam. To do this, an equation cam radius depending on its angle of rotation. Consider the example of derivation of the linear law increment helix blanks:

$$\Delta t_i = k_i \cdot x, \quad (4)$$

where  $k_i$  – the proportionality factor:

$$k_i = \frac{t_{\max} - t_{\min}}{L}, \quad (5)$$

where  $t_{\max}$  – the greatest step helix blank;  $L$  – current coordinate along the axis of the workpiece.

The equation of the kinematic balance to the compatibility condition. We proceed from the limits to the current coordinates:

$$\Delta r_i = \Delta R_{ki}(\Theta_i). \quad (5)$$

The equation defines the cam profile necessary to ensure uniform increment helical groove, in the absence of eccentricity between the pusher and cam axis.

Widespread serially-produced independent swing-separating devices Markets independent controllers, makes it possible to apply the principles of numerical control. This can greatly simplify the scheme cutting helical grooves and facilitate the changeover process system.

Another variant of the scheme cutting helical grooves with variable step involves the use of universal milling machine with horizontal spindle, equipped with a digital device indicating the position of the machine working bodies. These machines have the encoders in the coordinates. The sequence of impulses coming from the sensor mounted on the lead screw longitudinal table is converted into an analog signal using a digital to analog converter. The signal is then converted into alternating with the necessary frequency. To do this, set controlled oscillator frequency. Next, the resulting frequency is transmitted to the divider, which reduces the integer times the frequency supplied to it. The frequency divider is supplied to the electronic switch, which is controlled by a stepper motor.

The region of existence of the processing circuits depends on the tool and the machine

parameters. The minimum radius of the helical groove cavity is defined by the minimum possible radius of the tool.

The mandrel diameter is determined from the condition necessary to ensure the rigidity and vibration resistance, which in turn depends on the quality requirements of the treated surface and productivity.

Hence a minimum standard 16 mm diameter mandrel, the minimum radius of the cutter and, consequently, grooves and depressions 20 mm.

Widespread mass-produced independent swing-separating devices Markets independent controllers, makes it possible to apply the principles of numerical control. This can greatly simplify the scheme cutting helical grooves and facilitate the changeover process system.

In turn, there are several problems associated with milling flutes:

1. The high cost of the tool material.
2. Complex geometric shape of the cutting wedge which hinders productivity tool in the design process/
3. The complexity of manufacturing technology cutters.

Thus, to reduce the time and simplify the design tool technology, the acute problem of

the calculation of such mills. The calculation is made on-vysokoproiz-performance computing, so for correct calculation is necessary to analyze the methods of obtaining such milling tool surface.

Thus, the article received a set of equations to determine the law of variation of pitch helical groove that turns out high enough quality

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## METHODICAL AND TECHNOLOGICAL PECULIARITIES (FEATURES) OF 1C SOFTWARE PRODUCTS USING IN THE PREPARATION OF IT PROFESSIONALS AT THE UNIVERSITY

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An evident successful experience of training professionals with knowledge of software products "1C" has been accumulated as a result of long work in the vocational education system and at the Department of Informatics and Mathematical Methods in Economics of Naberezhnye Chelny Institute KFU Economics Division. We cannot formalize, determine and propose it as a universal model yet, but some main ideas are quite interesting and can be applied in other educational institutions.

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**Keywords:** 1C software products, educational-methodological complex, information technologies, cloud technologies, educational practice, internship, graduation projects competition, informal communication

With the development of information society, information technologies (IT), reaching a high level of development, more and more penetrate in all spheres of public life, including education. The problem is not only in the rapid development of IT, but also in IT training. The basic organizational stages of such staff preparation can be divided into four groups:

1) the "1C" company's software product line study in the framework of training programs for bachelors and masters, built in naturally-mathematical disciplines and professional unit block courses and electives;

2) students' participation in contests and competitions held by the company "1C";

3) organization and subsequent employment practices in organizations of the company "1C" partner network;

4) the students and professional practitioners informal thematic communication, the organization of workshops, discussions, business games and discussions (the profile shift group "The economic Olympus" in Dubravushka student camp, Grushin Festival arbuzniki (informal meetings) etc.

The main aim of training IT professionals in the training direction 03.09.03 (new code for GEF 3+) "Applied Informatics in Economics" and 38.03.05 "Business Informatics" is competences forming of the in the field of IT, methods and tools for the development and maintenance of information systems for different disciplines on the modern scientific and technical level.

Hardware, software and information resources make IT essentials. The effectiveness of training is largely determined by the sequence of connection and studied theoretical disciplines, supported and added by the courses with a practical orientation. For example junior students get acquainted with the history of IT

development, architecture and computer devices and communication systems, they study the theoretical foundations of economic information systems. On the basis of theoretical knowledge and with the economics disciplines study the students are involved in the development of methods and IT tools and aids. Graduate works of students have a practical focus and are often used by some organizations in their work.

The graduation works of IT-direction students are performed and commissioned by the city-forming enterprise "KAMAZ", finance, education, information and communication committees, banks and financial institutions of Naberezhnye Chelny and the Kama region, and many others. The experience of using IT in teaching process can be described by such components, as the technical, software, methodical, personnel and information provision, and students' achievements can illustrate its effectiveness.

The initial acquaintance of students with software products "1C" takes place in the first year in the "Computer science and programming" study. Students master the platform interface, programming elements in the "1C". "Education 1C" medium (environment) is actively used here.

Studying "Information systems and technologies" in the third year it is considered information, technical, technological and ergonomic provision and support of information systems. The typical configuration of the program "1C: Accounting 8.3" is used at the studies. Classes are held in computer labs using the network version of the program. The focus on this stage of training is given to the study of the composition and content of directories, originally presented in the program; to the study of details template forms composition of primary



documents; the content of the various chronological logs (postings, and other operations) is analyzed.

At the workshops the students learn the entire technological process chain, realized in the user's workplace. The students gain skills performing operations (from the data input to the report output) based on the test case materials. Thus, the practical work of the students is an illustration to the subject "Information technologies of an end-user".

Also in the third year the curriculum provides the discipline "Project Workshop". The students study the program "1C: Accounting 8.3" once again, but the work with the program is held in a different aspect. The educational-methodological complex of the discipline is focused on the program "1C: Accounting 8.3" as the base of technological capabilities and economic programs development. One section is dedicated to working with the program "1C: Accounting 8.3" as the platform "1C: Enterprise 8.2 (3)", which includes the program "1C: Accounting 8.3" is a powerful tool in dealing with the huge number tasks of any organization organizational and economic management.

The students learn programming elements in the "1C" acquire configuration skills, gain experience building applications based on the platform "1C: Enterprise 8.3", study the approaches to the implementation of programs "1C" at enterprises of various branches of economy. Another section is devoted to the development of software features "1C: Managing a small firm", which is the propaedeutics of corporate information systems use. At this stage cloud technologies are used actively.

It is a modern concept of IT, which is a distributed set of computing services, applications, access to information and data storage, without requiring the user knowledge of the systems physical location and configuration that provide these services. Training during service <https://edu.lcfresh.com/> is of great help in organizing and conducting classes with students.

In addition, in the third year studying the discipline "Information systems design" a future IT professional in the field of economics, a specialist in finance and management to gains the knowledge about corporate information systems practice, tries his hand in the supervisor position directly during the training, making decisions on which depends the success of an enterprise. This opportunity provides the use of software "1C" – "1C: Manufacturing Enterprise Management" in the educational process.

"1C: Manufacturing Enterprise Management" is a complete solution for business management, developed in accordance with the concept of ERP (Enterprise Resource Planning – Management and Enterprise Resources Planning).

The use of "1C: Manufacturing Enterprise Management" ensures the timely receipt of data required for analysis and decision-making. It focuses on the key business processes, which automation enables the largest financial results.

- financial management;
- production and warehouse logistics;
- Products supply and distribution;
- the enterprise human resources management;
- customer relationship management.

Software product "1C: Manufacturing Enterprise Management" study is aimed at the students' system of interrelated knowledge about the practical application of ERP-solutions development, at the willingness and ability to use them in their work. The widespread use of "1C: Manufacturing Enterprise Management" in Russian, Ukrainian and Kazakh companies is a guarantee of obtained knowledge demand on the part of employers.

In the fourth year according to the curriculum the discipline "Information Management" is provided. In the course of its development, the students have the opportunity to work with "1C" company materials. The materials posted on the website of the company "1C" on the Internet, as well as presented in the press. Information of the company "1C" is useful for the students in the preparation of reports, essays and reports on such policy issues as forms and methods of implementation of standard software products; assessment of the advantages and disadvantages of the purchase ready-made standard software products; approaches to the implementation of programs of the family "1C"; the implementation and operation of programs monitoring and many others.

Thus, the students specializing in "Applied Informatics (in the economy)", and "Business Informatics" are provided with the conditions of continuity in the study of specialized "1C" programs in various aspects, taking into account the content of basic education programs.

The main direction of the department is to improve the quality of educational services, standardization of teaching and methodological support of all readable disciplines, closer relationship of economic and technological disciplines, developing creativity and initiative of students and postgraduate students, the organization of regular seminars and schools

(electives) together with external companies and firms in the following areas:

- IT systems design methods and aids;
- modeling of business processes;
- IT line of IBM products, Microsoft, 1C;
- corporate information systems and technologies (large-scale databases, data warehouses, corporate portals).

The key factors to support modern IT is the preservation and strengthening of material-technical base of computer labs and classes, the further growth of the teaching staff qualification, the creation of teaching aids and materials in the format of websites and e-learning resources of training modules, the work on certification of experts from the number of students, postgraduate students and undergraduates.

One of the most effective events on the organization of students practices followed by employment on the base of partner "1C" company network organizations, as shown, was the "The Day of 1C: Career", which is traditionally held in November in many cities of Russia, Ukraine, Kazakhstan, Moldova. In Naberezhnye Chelny the event is held on the basis of a number of universities, including Naberezhnye Chelny Institute KFU since 2007, it's official organizer is the company "Firm LIST" unlimited ("1C" company's official partner in Naberezhnye Chelny).

Leading companies-partners "1C", well known in the Tatarstan information services market: 1C-Rarus, Intelkom, innovation center STEVE etc, participate in the "The Day of 1C: Career". The directors and leading specialists of partner companies are reporting at the plenary. The reports are focused on the franchising business in Tatarstan, on the production and pre-diploma practice and employment in companies-partners "1C". Also the students and graduates of NCHI KFU in the framework of this event have the opportunity to undergo preferential testing "1C: Professional". For seven years, "The Day 1C: Career" event in NCHI KFU was attended by over 3000 students and graduates.

Of great importance in the preparation of professionals with knowledge of software products "1C" is the participation of students in the Olympiad competition on programming of registration and analytical problems on the platform "1C: Enterprise" and the contest of graduation projects using the software "1C", conducted for several years by "1C" with the participation of regional distributors "1C". We believe that a real help to gain experience for the future professionals of the domestic IT in-

dustry and their leaders within the framework of these activities undoubtedly stimulates interest in the study of software products "1C" both by the students and by the teachers and contributes to the further successful employment of graduates.

Several years of informal dialogue practice shows that in creative collaboration with students the behavior of teachers is extremely diverse and determined by their individuality.

An organized profile shift group of students "The economic Olympus" in the student camp Dubravushka NCHI KFU, as well as the visits to Grushin Festival, arbuznikovs meetings demonstrated well that the pupil-student is able to see for himself the personal meaning in learning professional skills. Students have the opportunity not only to express their attitude to current events, but also to justify and defend their own opinions. The teacher, professionals, and students are absolutely equal as speech partners, IT professionals, possessing an extensive range of modern IT, engineering skills, which is conducive to the creation of comfortable psychological climate for communication.

With all this diversity the logical center which determines, educates and develops the effects of such cooperation is always the respect for the student personality – that is the sense of equality which distinguishes the subject-subject relationship of the student with a potential employer.

Thus, the future IT professional, a teacher and his specialists- teachers are involved in human culture context, different languages, arts, ways of life in all their originality, which contributes to the completeness and the depth of the compliance with profession, that is, the level of a specialist with significant experience.

### Conclusions

The demand for IT professionals with skills of business analysts and economic analysis in an environment of modern information systems (IS) is very high. IT equip and reproduce almost all the techniques of financial management, marketing and logistics, rules and regulations of accounting and tax accounting, accounting policy and MSFO and managerial accounting standards. Therefore, the target oriented disciplines disclosing the use of information systems in business management and economic activity in large enterprises are more often included in the bachelor's education curricula nowadays.

Thus, for the education of bachelors in NCHI KFU, specializing in “Applied Computer Science” and “Business Informatics” practical orientation of training is provided with maintaining the necessary theoretical basis. To do this, the main content of training is focused on the best practices of higher education institutions and the requirements of potential employers to the competencies of graduates. The ability to work with the software “1C” expands the range of graduate employment, allows to obtain production skills, which brings confidence and, consequently, increases the professionalism of the future IT specialist and his competitiveness in the labor market.

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## THE DETERMINATION AND APPROXIMATION OF THE FEASIBLE AND PARETO SETS

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When addressing different methods of optimization in order to solve engineering optimization problems it is usually assumed that these problems are defined correctly. However, very often, this assumption is not true. Therefore, in the overwhelming majority of cases, the expert ends up solving ill-posed problems. In order to search for the best solutions, we first need to define the feasible solution set. This task generally presents serious, at times insurmountable difficulties. The correct determination of the feasible solution set is a major challenge in engineering optimization problems. In order to construct the feasible solution set, a method called the Parameter Space Investigation (PSI) has been created and successfully integrated into various fields of industry, science, and technology. Besides the PSI method, the methods of approximation of the feasible solution and Pareto optimal sets are considered in our paper. The issues of the estimation of the PSI method convergence rate, the approximation of the feasible solution set and Pareto optimal set, and the regularization of the Pareto optimal set are described.

**Keywords:** feasible solution set, PSI method, uniformly distributed sequences, Pareto optimal set, approximation

### Generalized Formulation of Multicriteria Optimization Problems

Let us consider an object whose operation is described by a system of equations (differential, algebraic, etc.) or whose performance criteria may be directly calculated. We assume that the system depends on  $r$  **design variables**  $\alpha_1, \dots, \alpha_r$ , representing a point  $\alpha = (\alpha_1, \dots, \alpha_r)$  of an  $r$ -dimensional space.

In the general case, when designing a machine, one has to take into account the design variable constraints, the functional constraints, and the criteria constraints [1].

The **design variable constraints** (constraints on the design variables) have the form

$$\alpha_j^* \leq \alpha_j \leq \alpha_j^{**}, \quad j = 1, \dots, r. \quad (1)$$

Obviously, the constraints (1) single out a parallelepiped  $\Pi$  in the  $r$ -dimensional design variable space.

The **functional constraints** may be written as follows:

$$C_l^* \leq f_l(\alpha) \leq C_l^{**}, \quad l = 1, \dots, t, \quad (2)$$

where  $f_l(\alpha)$  are the **functional dependences**. The functional constraints can specify the range of allowable stresses in structural elements, the track gauge, etc.

There also exist particular performance criteria, such as productivity, materials consumption, and efficiency. It is desired that, with other things being equal, these criteria, denoted by  $\Phi_v(\alpha)$ ,  $v = 1, \dots, k$  would have the extreme values. For simplicity, we assume that  $\Phi_v(\alpha)$  are to be minimized.

In order to avoid situations in which the expert regards the values of some criteria

as unacceptable, we introduce the criteria constraints

$$\Phi_v(\alpha) \leq \Phi_v^{**}, \quad v = 1, \dots, k, \quad (3)$$

where  $\Phi_v^{**}$  is the worst value of criterion  $\Phi_v(\alpha)$  to which the expert may agree.

The criteria constraints differ from the functional constraints in that the former are determined when solving a problem and, as a rule, are repeatedly revised. Hence, unlike  $C_l^*$  and  $C_l^{**}$ , reasonable values of  $\Phi_v^{**}$  cannot be chosen before solving the problem.

Constraints (1)–(3) define the feasible solution set  $D$ .

Let us formulate one of the basic problems of multicriteria optimization. It is necessary to find such a set  $P \subset D$  for which

$$\Phi(P) = \min_{\alpha \in D} \Phi(\alpha), \quad (4)$$

where  $\Phi(\alpha) = (\Phi_1(\alpha), \dots, \Phi_k(\alpha))$  is the criterion vector and  $P$  is the Pareto optimal set.

**Definition 1.** A point  $\alpha^0 \in D$ , is called the Pareto optimal point if there exists no point  $\alpha \in D$  such that  $\Phi_v(\alpha) \leq \Phi_v(\alpha^0)$  for all  $v = 1, \dots, k$  and  $\Phi_{v_0}(\alpha) < \Phi_{v_0}(\alpha^0)$  for at least one  $v_0 \in \{1, \dots, k\}$ .

A set  $P \subset D$  is called the Pareto optimal set if it consists of Pareto optimal points. When solving the problem, one has to determine a design variable vector point  $\alpha^0 \in P$ , which is most preferable among the vectors belonging to set  $P$ .

The Pareto optimal set plays an important role in vector optimization problems because it can be analyzed more easily than the feasible

solution set and because the optimal vector always belongs to the Pareto optimal set, irrespective of the system of preferences used by the expert for comparing vectors belonging to the feasible solution set. Thus, when solving a multicriteria optimization problem, one always has to find the set of Pareto optimal solutions.

The features of the problems under consideration make it necessary to represent vectors  $\alpha$  by points of uniformly distributed sequences or the  $P_\tau$  net in the space of design variables [2].

### The Correct Definition of The Criteria Constraints

The feasible set, in its turn, depends on the correct definition of the criteria constraints  $\Phi_v^{**}$ . The values of these constraints must be a maximum from all possible values of the respective criteria. Otherwise, since the criteria may be contradictory, many feasible solutions may be lost. Thus, the solution of a multicriteria optimization problem to considerable extent is reduced to the correct definition of  $\Phi_v^{**}$ . The Parameter Space Investigation method, which allows correct determination of  $\Phi_v^{**}$  and, hence, of the feasible solution set. The PSI method involves the following three stages [1].

The Pareto optimal set  $P$  is then constructed in accordance with the definition presented above. This is done by removing those feasible points that can be improved with respect to all the criteria simultaneously.

Let us describe the procedure for constructing the maximum feasible solution set. As a rule, the expert may set  $\Phi_v^{**}$  equal to a criterion value  $\Phi_v(\bar{\alpha})$  whose feasibility is beyond doubt.

If the selected values of  $\Phi_v^{**} = \Phi_v(\bar{\alpha})$  are not the maximum ones, then one is not sure whether the values of  $\Phi_v(\alpha)$  from the interval  $\Phi_v(\bar{\alpha}) \leq \Phi_v(\alpha) \leq \tilde{\Phi}_v^{**}$  are feasible. In this case one has to construct the feasible solution set  $D$  for the constraints  $\Phi_v^{**} = \Phi_v(\bar{\alpha})$  and the corresponding Pareto optimal set  $P$ . Further, the set  $\tilde{D}$  is constructed for the constraints  $\tilde{\Phi}_v^{**}$   $v = 1, \dots, k$ , as well as the corresponding Pareto optimal set  $\tilde{P}$ . Let us compare  $\Phi(P)$  and  $\Phi(\tilde{P})$ . If the vectors belonging to  $\Phi(\tilde{P})$  do not improve substantially the values of the vectors from  $\Phi(P)$ , then one may set  $\Phi_v^{**} = \Phi_v(\bar{\alpha})$ . Otherwise, if the improvement is significant, then the values of the criteria constraints may be set equal to

$\tilde{\Phi}_v^{**}$ . In this case one has to make sure that the optimal solutions thus obtained are feasible. If the expert is unable to do this, then the criteria constraints are set equal to their previous values,  $\Phi_v^{**} = \Phi_v(\bar{\alpha})$ . This scheme can be used for all possible values of  $\Phi_v(\bar{\alpha})$  and  $\tilde{\Phi}_v^{**}$  [3].

After analyzing  $P$ , the expert finds the most preferred solution  $\Phi(\alpha^0)$ . As already noted, for the problems under consideration, experts do not encounter serious difficulties in analyzing the Pareto optimal set and in choosing the most preferred solution. Thus, the PSI method has proved to be a very convenient and effective tool for the expert.

### Approximation of the Feasible Set

The algorithm discussed in [3] allows simple and efficient identification and selection of feasible points from the design variable space. However, the following question arises: How can one use the algorithm to construct a feasible solution set  $D$  with a given accuracy? The latter is constructed by singling out a subset of  $D$  that approaches any value of each criterion in region  $\Phi(D)$  with a predetermined accuracy.

Let  $\varepsilon_v$  be an admissible (in the expert's opinion) error in criterion  $\Phi_v$ . By  $\varepsilon$  we denote the error set  $\{\varepsilon_v\}$ ,  $v = 1, \dots, k$ . We will say that region  $\Phi(D)$  is approximated by a finite set  $\Phi(D_\varepsilon)$  with an accuracy up to the set  $\varepsilon$ , if for any vector  $\alpha \in D$ , there can be found a vector  $\beta \in D_\varepsilon$  such that

$$|\Phi_v(\alpha) - \Phi_v(\beta)| \leq \varepsilon_v, \quad v = 1, \dots, k.$$

We assume that the functions we shall be operating with are continuous and satisfy the Lipschitz condition ( $L$ ) formulated as follows: For all vectors  $\alpha$  and  $\beta$  belonging to the domain of definition of the criterion  $\Phi_v$ , there exists a number  $L_v$  such that

$$|\Phi_v(\alpha) - \Phi_v(\beta)| \leq L_v \max_j |\alpha_j - \beta_j|.$$

In other words, there exists  $L'_v$  such that

$$|\Phi_v(\alpha) - \Phi_v(\beta)| \leq L'_v \sum_{j=1}^r |\alpha_j - \beta_j|.$$

We will say that a function  $\Phi_v(\alpha)$  satisfies the special Lipschitz condition ( $SL$ ) if for all vectors  $\alpha$  and  $\beta$  there exist numbers  $L'_v$ ,  $j = 1, \dots, r$  such that

$$|\Phi_v(\alpha) - \Phi_v(\beta)| \leq \sum_{j=1}^r L'_v |\alpha_j - \beta_j|,$$

where at least some of the  $L'_v$  are different.

Let  $[L_v]$  (or  $\left[ \sum_{j=1}^r L_v^j \right]$ ) be a dyadic rational number exceeding  $L_v$  (or  $\sum_{j=1}^r L_v^j$ ) and sufficiently close to the latter, and let  $[\varepsilon_v]$  be the maximum dyadic rational number that is less than or equal to  $\varepsilon_v$  and whose numerator is the same as that of  $[L_v]$  (or  $\left[ \sum_{j=1}^r L_v^j \right]$ ). A dyadic number is a number of the form  $\frac{p}{2^m}$ , where  $p$  and  $m$  are natural numbers.

**Theorem 1.** If criteria  $\Phi_v(\alpha)$  are continuous and satisfy either the Lipschitz condition or the special Lipschitz condition, then to approximate  $\Phi(D)$  to within an accuracy of  $\varepsilon$  it is sufficient to have

$$\max_v 2^\tau \left( \frac{[L_v]}{[\varepsilon_v]} \right)^r \text{ or } \max_v 2^\tau \left( \frac{\left[ \sum_{j=1}^r L_v^j \right]}{[\varepsilon_v]} \right)^r$$

points of the  $P_\tau$  net. For details on  $\tau$ , see [2].

The number of points needed to calculate the performance criteria in this estimate may be so large that the speed of present-day computers may prove to be inadequate. This difficulty may be overcome by developing "fast" algorithms dealing not with an entire class of functions but instead taking into account the features of the functions of each concrete problem.

To approximate a feasible region  $\Phi(D)$ , such an algorithm may be constructed in the following way. (Although all subsequent considerations presume that the Lipschitz condition is satisfied, they are valid as well for the special Lipschitz condition if constant  $L_v$  is replaced by  $\sum_{j=1}^r L_v^j$ .)

Let the Lipschitz constants  $L_v$ ,  $v = 1, \dots, k$ , be specified, and let  $N_1$  be the subset of the points  $D$  that are either the Pareto optimal points or lie within the  $\varepsilon$ -neighborhood of a Pareto optimal point with respect to at least one criterion. In other words,  $\Phi_v(\alpha^0) \leq \Phi_v(\alpha) \leq \Phi_v(\alpha^0) + \varepsilon_v$ , where  $\alpha^0 \in P$ , and  $P$  is the Pareto optimal set. Also, let  $N_2 = D/N_1$  and  $\bar{\varepsilon}_v > \varepsilon_v$ .

**Definition 2.** A feasible solution set  $\Phi(D)$  is said to be normally approximated if any point of set  $N_1$  is approximated to within an accuracy of  $\varepsilon$ , and any point of set  $N_2$  to within an accuracy of  $\bar{\varepsilon}$ .

**Theorem 2.** There exists a normal approximation  $\Phi(D_\varepsilon)$  of a feasible solution set  $\Phi(D)$  [3].

### The Pareto Optimal Set Approximation

Since the Pareto optimal set is unstable, even slight errors in calculating criteria  $\Phi_v(\alpha)$  may lead to a drastic change in the set. This implies that by approximating a feasible solution set with a given accuracy we cannot guarantee an appropriate approximation of the Pareto optimal set. Although the problem has been tackled since the 1950s, a complete solution acceptable for the majority of practical problems is still to be obtained. Nevertheless, promising methods have been proposed for some classes of functions.

Let  $P$  be the Pareto optimal set in the design variable space;  $\Phi(P)$  be its image; and  $\varepsilon$  be a set of admissible errors. It is desirable to construct a finite Pareto optimal set  $\Phi(P_\varepsilon)$  approximating  $\Phi(P)$  to within an accuracy of  $\varepsilon$ .

Let  $\Phi(D_\varepsilon)$  be the  $\varepsilon$ -approximation of  $\Phi(D)$ , and  $P_\varepsilon$  be the Pareto optimal subset in  $D_\varepsilon$ . As has already been mentioned, the complexity of constructing a finite approximation of the Pareto optimal set results from the fact that, in general, in approximating the feasible solution set  $\Phi(D)$  by a finite set  $\Phi(D_\varepsilon)$  to within an accuracy of  $\varepsilon$ , one cannot achieve the approximation of  $\Phi(P)$  with the same accuracy. Such problems are said to be ill-posed in the sense of Tikhonov [4]. Although this notion is routinely used in computational mathematics, let us recall it here.

Let  $P$  be a functional in the space  $X$ ,  $P: X \rightarrow Y$ . We suppose that there exists  $y^* = \inf P(x)$ , and  $V_\varepsilon(y^*)$  is the neighborhood of the desired solution  $y^*$ . Let us single out an element  $x^*$  (or a set of elements) in space  $X$  and its  $\delta$ -neighborhood  $V_\delta(x^*)$  and call  $x_\delta^\varepsilon$  a solution to the problem of finding the extremum of  $P$  if the solution simultaneously satisfies the conditions  $x_\delta^\varepsilon \in V_\delta(x^*)$  and  $P(x_\delta^\varepsilon) \in V_\varepsilon(y^*)$ . If at least one of the conditions is not satisfied for arbitrary values of  $\varepsilon$  and  $\delta$ , then the problem is called ill-posed (in the sense of Tikhonov).

An analogous definition may be formulated for the case when  $P$  is an operator mapping space  $X$  into space  $Y$ . Let us set

$$X = \{\Phi(D_\varepsilon), \Phi(D)\}; Y = \{\Phi(P_\varepsilon), \Phi(P)\},$$

where  $\varepsilon \rightarrow 0$ , and let  $P: X \rightarrow Y$  be an operator relating any element of  $X$  to its Pareto optimal subset. Then in accordance with what was said before, the problem of constructing sets  $\Phi(D_\varepsilon)$  and  $\Phi(P_\varepsilon)$  belonging simultaneously to the  $\varepsilon$ -neighborhoods of  $\Phi(D)$  and  $\Phi(P)$ , respectively, is ill-posed. Of course, in spaces  $X$  and  $Y$ , the metric or topology, that corresponds to the system of preferences on  $\Phi(D)$  must be specified [5].

Let us define the  $V_\varepsilon$  – neighborhood of a point  $\Phi(\alpha^0) \in \Phi(\Pi)$  as

$$V_\varepsilon = \left\{ \Phi(\alpha) \in \Phi(\Pi) : \left| \Phi_v(\alpha^0) - \Phi_v(\alpha) \right| \leq \varepsilon_v, \quad v = 1, \dots, k \right\}.$$

In Theorem 3, we have to construct a Pareto optimal set  $\Phi(P_\varepsilon)$  in which for any point  $\Phi(\alpha^0) \in \Phi(P)$  and any of its  $\varepsilon$ -neighborhoods  $V_\varepsilon$  there may be found a point  $\Phi(\beta) \in \Phi(P_\varepsilon)$  belonging to  $V_\varepsilon$ . Conversely, in the  $\varepsilon$ -neighborhood of any point  $\Phi(\beta) \in \Phi(P_\varepsilon)$ , there must exist a point  $\Phi(\alpha^0) \in \Phi(P)$ . The set  $\Phi(P_\varepsilon)$  is called an approximation possessing property  $M$ . Let  $\Phi(D_\varepsilon)$ , an approximation of  $\Phi(D)$ , have been constructed.

**Theorem 3.** If the conditions of Theorem 1 are satisfied, then there exists an approximation  $\Phi(P_\varepsilon)$  of Pareto set  $\Phi(P)$  possessing the  $M$  – property.

The theorem will be proved by analyzing the neighborhoods of the so-called “suspicious” points from  $\Phi(D_\varepsilon)$ , that is, the points to whose neighborhoods the true Pareto optimal vectors may belong. If we find new Pareto optimal vectors in the neighborhoods of the “suspicious” points then these vec-

tors may be added to  $\Phi(P_\varepsilon)$ . Taken together with  $\Phi(P_\varepsilon)$ , they form the  $\varepsilon$ -approximation of a Pareto optimal set, [5].

In [5] it is shown that this approach solves the problem of the ill-posedness (in the sense of Tikhonov) of the Pareto optimal set approximation.

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## DEVICES TO BEAT OUT THE FLAMES OF ROCKET PROPULSIVE JETS AT SPACESHIP STARTING

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New generation of automatic fire-extinguishing systems to beat out the flames at the spaceship launch area is proposed. The modernization consists in supplementary equipping of the existing fire-extinguishing automatic systems used at the launch ground by the multi-barrel modules (MMs) with volley dispersion of the extinguishing media. The parallel executive system consisting of several MMs situated around the launch area at the distances from 50 to 200 m can be also created. This modernization of fire-extinguishing systems can protect the launch complex structures from the high-power rocket engine flame jets quickly, effectively and fully. It can also provide the effective light radiation and heat protection and prolong the life duration of the expensive start facilities. The correctness of the proposed project is confirmed by the results of the last successful tests of the modern MBMs ensemble situated around the goal in semi-circular order which concentrated their volleys on the alone local but powerful flame.

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**Keywords:** Spaceship, Starting, Propulsive Jets, Rocket, automatic fire-extinguishing systems

### Actuality of the Topic

The analysis of the rocket launch area fire protection practice during the last several dozens years have shown the low effectiveness of the high-power water supply systems (with water supply rate from 330 up to 500 liters per second) designed to beat out the flames of the launch rocket engines. It was quite convincing at the series of rocket launches in USA (Cape Canaveral) when the executive systems provided the real waterfalls but could not protect the launch facilities satisfactorily and in time [1, 2]. Up-to-date water monitors (water supply cannons) can not provide enough water in very small time duration due to their high complexity, the large time lag from the initial signal to water emission, and also due to their low reliability at the extreme work regimes. The monitors require dozens seconds from the initial signal to the maximum water supply regime beginning [3, 4]. It means that the water emission to the rocket launch complex should begin in the minute before rocket start, and it can not be admitted. In rocket launch reality, water emission should begin only just after the rocket separation from the ground. As an alternative, it can be accepted that the monitors sprinkle the water to some other side before the rocket separation, and turn to the launch facilities only after it. But the strong water cannon turns around not more quickly than the tank turret (really, in 20–30 seconds). The launch facilities undergo the powerful flame heating during this time, and their posterior cooling is not effective, even from their integrity point of view. The most intensive and destructive flame

heat action corresponds to time lag from 10 to 30 seconds after the rocket separation.

The above-mentioned lacks of the executive hydraulic systems, such as sprinklers, drenchers, and hydro-monitors, were known in 1980s yet [5–7]. It was a reason why the Soviet ministries respondent for fuel and energy as well as the Ministry of Defense financed in 1982–1991 (till the USSR collapse) the research works aimed to design principally new fire-extinguishing executive subsystems. These subsystems were both stationary impulse facilities directed to the fire source and mobile systems based on trailers and gun carriages. The impulse MM systems provided the volley dispersions of the various fire-extinguishing media (different liquids, gels, powders, dust, or sand). Combined fire extinguishing easily controlled on type, scale and power of action, minimum extinguishing media expense less harmful to buildings and equipment, high distance and precision of action on any areas, system compactness and absence of pumps, pipelines and tanks for extinguishing media, and safety for personnel were their important advantages.

The armored track-type fire service machines “Impulse-3M” with 50-barrelled turret MMs based on T-62 Soviet tank chassis worked successfully in Ukrainian (6 machines) and Russian (up to 10 machines) fire units till nowadays. They are used primarily at nuclear power plants, in chemical, oil and gas industry. Their application to ammunition storages and rocket launch areas is also recommended.

But, in spite of numerous designers’ letters and papers in special journals, the development of impulse fire-extinguishing systems



were never supported neither in Russia nor in Ukraine. New wave of interest to this research arose in last several years due to industrial accident, terrorist attacks, and forest fire scale and quantity growth. Some number of the industrial projects is being realized now in China, the Czech Republic, Estonia and Finland under Prof. V.D. Zakhmatov's scientific supervision. Financial support and work intensity are especially high in China, and it allowed us in the last two years to reach new results discussed in the final part of this paper.

### **The Modern State in Extinguishing Media Supply Systems**

The experience of the series of the industrial accidents in peace time has shown that the effectiveness of some up-to-date fire systems (even the best American and European models) is not satisfactory. The gun-carriage fire barrels with 70–330 liters per second (lps) water (or low-expansion foam) supply rate and hydro-monitors with water supply rate up to 400 lps seems to be most effective and vigorous nowadays. They are expensive, sophisticated, difficult in everyday service, and require the long time for their installation and work beginning.

The tragic death of more than 20 firemen and 4 fire cars covered by burning oil splash at oil storage fire in Vasilkov (Kiev region, Ukraine, 2015) demonstrated the necessity of fire extinguishing of all dangerous objects from the maximum distances. Up to our experience, the eruptions of dozens tons of burning oil and oil products to the distance up to 300–500 meters from the reservoir with the formation of large burning “lakes” are known. The requirements to the fire-extinguishing systems in large-scale oil fires (quick, safe and precise beating the flame out at the given limited area with its following cooling) are some analogous to the requirements in the case of rocket launch.

The impulse fire-extinguishing systems combine the uniform blow by the continuous dense wave front beating the flame out and fire-directed water dispersion. Its effectiveness depends on such factors as:

- operability of its action on the fire flashpoint;
- sufficient concentration of the fire area irrigation by water or low-expansion foam which also can be delivered on relatively large distances (low-expansion foam range distance is approximately 10% less than water jet one [1]).

To improve these factors, most modern and powerful gun-carriage barrels are used to extinguish the fire on dangerous industrial objects [2, 3]. The theory of high-velocity jet flows confirms [] that such facilities provide

us the maximum range of jet flow flight which allows the firemen to be situated at relatively safe distance from the flame vortex front [1, 4]. But even the most modern specimens of gun-carriage barrels with water supply rate equal to 70, 100 and 150 lps provide the maximum range distance up to 110 meters. It is evidently insufficient for personnel safety at flame extinguishing.

Another unsolved problem is the control of high dynamic pressure jet irrigation square. When we enlarge supply rate and range distance, we inevitably widen the irrigation square, even in windless weather. Multiple expensive attempts of barrel modernization and surface strength factor enlargement due to fluid viscosity growth have no positive results up now. Even at the windless weather, at liquid supply rate equal to 100–150 lps, the dispersion of liquid droplets is more than 100–200 meters, instead of the optimal distance equal approximately to 40–60 meters. Wind changes the irrigation area configuration crucially and shifts the liquid droplets up to 1 kilometer. As a result, only minor part of the dispersed water or low-expansion foam really hits the reservoir of fuel or the rocket launch burning facilities.

As a result of low fire-extinguishing system effectiveness, the firemen can work up to several hours in dangerous and harmful (due to solid of liquid rocket propellants, for example) under the menace of sudden fire front attack. So the manufacturers of the fire equipment waste a lot of their means to enlarge the range distance and to diminish the area of the distance irrigation. To solve these problems means to provide the safe extinguishing of the burning reservoirs at the small time till the beginning of dangerous pollutions or contemporarily with the rocket separation, to provide the thermal protection of the launch facilities and to save it for the future starts with minimal repairs.

We also should remark that even the most powerful systems of launch facilities cooling are not able to extinguish the large-scale fires and to deactivate the pollution of the toxic rocket propellant. This is crucially important, because it is typical situation at the rocket collapse at its start, and also when the parts of rocket and its fuel reservoirs drop, explode and burn in dozens seconds after the start at the space launching site territory.

The fire safety cars are applied to this goal traditionally. Their work is based of the release of hundreds tons of water and the sedimentation of the poisonous clouds by dispersed jets. The electronics of such systems is well-developed and unified in different countries. But the

mechanics of their executive devices consisting of the pipelines, high-pressure tanks, large and heavy reservoirs and powerful pumps is very complicated and slow.

To avoid these important problems in long-distance fire-extinguishing mechanics, we propose to equip the automatic quenching systems by cheap, easily and quickly installed executive system consisting of MBMs with volley dispersion of fire-extinguishing, heat-protecting, pollution-localizing media.

#### **History of Impulse Fire-Extinguishing System Applications**

Multi-barrel modules (MMs) were designed from the beginning of 1980s, at first as the authors' initiative, and as a part of the Soviet state military and industrial programs after it. Those were MMs which dispersed water by its shot or volley mounted at two-axis gun carriages or at sledge runners. They were produced in a large number and tested successfully at field as well as at real fires in industry. The first 4-barrelled module (MM-4) was designed and tested under V.D. Zakhmatov's scientific guidance in the Moscow High Engineering and Technical School of the Soviet Interior Ministry in 1982. Since 1983, the 9-barrelled modules (MM-9) based on nine wagons began to be manufactured in Sverdlovsk (now – Yekaterinburg, Russia) at the Urals Staff of Mine-Rescue Works enterprise. They were widely used at the mines of the Soviet Non-Ferrous Metallurgy Ministry afterwards.

New MM (MM-8) was demonstrated at the Soviet Civil Defense test field in Konchazspa (near Kiev) in September, 1984 at the All-Soviet Maneuvers of the Civil Defense. The burning stack of wood was successfully extinguished from the distance of 50 meters during 2 seconds. This MM-8 module was designed under V.D. Zakhmatov's supervision in the repair shop of Kiev civil defense regiment. The full volley of its 8 barrels dispersed 120 kg of fire-extinguishing powder and created the gas-particle vortex with effective range up to 60 meters. As the vortex spreading, it widened its front from 1 to 8 m in width and from 0,5 to 3 m in height. The effective area of fire extinguished reached 350 square meters and was shaped as oblong drop longitudinal cross-section.

At that time and until nowadays, the pneumatic one-barrel impulse dispersion system elaborated by Prof. I.M. Abduragimov and Dr. V.A. Makarov (Moscow High Engineering and Technical School of the Soviet Interior Ministry []) was the only rival of the mentioned MMs at

Soviet and post-Soviet territories. It pulverizes up to 200 kg of the fire-extinguishing powder to the distance not more than 15–20 meters. So it can extinguish a fire of the low-pressure gas fountains from the distance up to 10 meters. One-barreled systems are also inconvenient, because their recoil is larger than the recoil of the multi-barrel systems of the same media supply rate and jet velocity (up to 20–35% in the above-mentioned case, for example).

Up to 40 MMs (MM-9, MM-16) were manufactured at the pilot plants of the Soviet Academy of Sciences in May-July, 1986. They were actively applied in the zone of the Chernobyl catastrophe (near Kiev, 1986) to defend the transformer stations and to extinguish some parts of the 3<sup>rd</sup> and the 4<sup>th</sup> units of the Chernobyl nuclear power plant which suffered much of blast and radiation. MM-8, MM-9 and MM-25 were successfully applied to quench the fire of 14 gas and oil wells at Neftyanje Kamni ("Oil Stones" at Caspian Sea, now in Azerbaidzhan). These MMs were mounted at the wide deck of torpedo boat and, after it, at the high deck of Finnish floating crane. They were arrayed and directed in such manner for the vortices formed by the neighbor MMs were to meet at the 80–100 m distance. It allowed us to reach the maximum effectiveness to beat out the turbulent integral fountain torch from the relatively safe distance. A volley of 40 barrels created a mighty tornado with the front width up to 20 meters, front height up to 5 meters. After the flame beating out, oil workers were landed to the oil platform deck to block the well without risk of the secondary inflammation. MMs acted simultaneously with the fire safety ships of the Caspian and Volga flotilla, but they sufficiently excelled the fire ship in the range and scale of the fire-extinguishing tornado. At the same industrial accident, our MMs were effectively used to localize the oil pollution producing the large-scale dispersion of the oil sorbates (granulated turf) onto the oil film.

High-power and long-distance 9-barrelled MM based on two-axis gun carriage diffuses up to 180 kg of fire-extinguishing media on the range up to 90 meters by the area square up to 500 square meters at its only volley from all its barrels. More powerful systems were designed some later, for example, 25-barrelled MM which disperses 120–135 kg of useful media on the distance up to 60–70 meters by each its volley from 8–9 active barrels. Its fire-extinguishing area reaches 350–400 square meters by alone volley, 1200 square meters

at volleys with long intervals between them, and up to 2500 square meters when the intervals between volleys are equal to 3–5 seconds. 30-barrelled recoilless MM with 152 mm barrel caliber (the barrels are optionally removable) which disperses 75–90 kg of the extinguishing media by each volley from 5–6 barrels on 40–45 m distance and quenches 150–200 square meters area by each volley was also designed and tested.

New construction of the stationary MM to be mounted on the two-axis gun carriage which includes the hermetic containers for liquids and gels was designed in 2013–2014. Hermetic containers for the working media are firm enough for their transportation, reload and charge, but, at the same time, they can be easily destroyed by the propelling wave of gunpowder gases into small and light pieces which are not dangerous and fly out not more than to 10 meters. The dispersing charges are manufactured in most convenient and safe for personnel modification. The metal cartridges with electric capsule bushing were manufactured in China industrially. The last stage of the field tests was conducted in 2014–2015 and revealed the high possibilities of the modified MM-9, MM-20 and MM-30 modules. They extinguished the strong standard fire source in 1 second from 100 m distance. The vortex of the working media spreads more than to 200 meters, and the subjected area square was up to 1000–1200 square meters at the every volley of 200 kg of the useful media from 10 barrels.

The most completed multi-barreled system, MM-50 based on T-62 Soviet tank chassis, is known at fire safety car “Impulse-3M”. It is used in Ukraine (7 systems) and in Russia (12 systems) from 1992 till nowadays. “Impulse-3M” can be used at the temperature range from –50 to +50 °C. This fact makes it applicable in different weather conditions, from cold Russian North, Siberia and Far East cosmodromes (“Plesetsk”, “Baykonur”, “Vostochny”) to the tropical launch areas (Florida, French Guiana). One volley produced from 10 barrels disperses 250 kg of the fire-extinguishing powder up to 110 meters. A series of 5 volleys covers the area up to 3000 square meters without barrel recharge. We do not know the analogous systems applicable for fire extinguishing in toxic, blast-dangerous or radioactive surroundings where the quickness and accuracy of volley, as well as the armor protection for personnel are very important. A wide range of the ecologically pure natural ma-

terials (soil, sand, dirt, dust) can be used as the working media. Due to above-mentioned advantages, this machine can be effectively applied to launch complex cooling, as well as for the suppression of any accidents at the launch area, including rocket destruction at the beginning of the trajectory or immediately at start. “Impulse-3M” is armored; it has also light and heat radiation protection systems, and can be used as bulldozer to operate inside construction debris.

“Impulse-3M” MMs are used now at the chemical industry enterprises (“Azot” factory in Cherkassy, Ukraine), in radioactive areas (Chernobyl, Ukraine) and nuclear power plants (Balakovo, Russia), as well as in oil and gas industry (specialized unit for the suppression of gas and oil fountains, Poltava, Ukraine; fuel enterprises “Gnezdinsky” (Chernigov region, Ukraine), in Syzran (Samara region, Russia), and in Bashkortostan, Russia), and also in mining industry (Norilsk, Russia). It seems possible to apply the “Impulse-3M” MMs to rocket launch sites, but it should be more effective to modify its construction using special containers and dispersing charges of original design that are manufactured in China now. The universal containers are at the first time fit for almost every working media, such as liquids, gels, powders, and other natural materials which can be found at the place of accident and can be applicable for fire extinguishing, localization and deactivation of harmful pollutions. For example, microbiological remedies and alive microorganisms can be used for biological destruction of oil and rocket propellant pollutions, their ecological screening and soil re-cultivation.

#### **Special Multi-Barreled Modules to be Mounted Around the Rocket Launch Site**

Special MM (“MM-laf”) can be designed as stationary one or based on gun carriage or on trailer. Its prototypes based on two-axis gun carriages were consisted of 7–10 or 25 barrels and applied to fire extinguishing in Chernobyl area, coal and ore mines, burning airplane at the runway, etc. The recoil of this MM does not exceed 1–3 meters at the volley from 9 barrels.

“MM-laf” system does not require the special maintenance works except of the initiation electric chain checking by small-amperage electric impulse. As a measure of supplementary safety control, 1 or 2 barrels can be changed every year.



**Fig. 1.** Field tests of the joint concentrated action of various improved MMs (MM-9, MM-20, MM-30) in China (December, 2014)

If the system is properly charged, and containers with useful media and the pulverizing cartridges are assembled qualitatively, “MM-laf” is reliable even when this system stands 5 years without practice. Containers with fire-extinguishing media can, after all improvements, reach reliable workability after 15 years storage. “MM-laf” also can be situated around the dangerous area very quickly, and this is an important advantage of those systems in emergencies.

Very convincing ground tests on multiple protection of the fire-dangerous area by different MMs were conducted in China in December, 2014. Three improved MMs participated in testing: MM-20 made the first volley from 100 m distance, MM-30 made the second one from 120 m, and MM-9 made the third volley from 85 meters. Model of the standard fire hotbed was extinguished by the very first volley; two other volleys demonstrated the reliable workability of the system and its multiple usages only. It was demonstrated also that the fire suppression with several MMs can be combined due to programmed dispersion of different working media from the various distances with different time intervals.

For any facility to be protected, the principles of flame spreading can be studied depending on a number of factors (technologies and regimes of its applications, possibilities to switch off the power cables and fuel pipelines, the special features of the separate apparatus and venting, etc.). When the fire appearance and spreading is studied, it helps to determine the optimal fire-fighting tactics. Speaking about MMs, it is an order of volleys produced by groups of MMs and separate MMs and time intervals between them. The effectiveness of MM assembly depends on easiness of their work program change and correction, if the conditions at the protected area are changed during the fire development. MMs can change their positions, order of volleys and number of barrels participating in each volley, and this makes the assembly work not only powerful, but also very flexible.

Fire sensors and other transducers can be applied at the same system with the MM complex. It can help the system to cope with the arsons and quickly-developing fires. So not only possibilities to apply different liquids, gels, powders and other media is this system

advantage, but also the possibility of the flexible control on the basic impulse dispersion parameters, such as distance, scale and the shape of the moistened area. This type of control is achieved by the variation of the number of barrels, their mutual position in the same volley and in the different volleys, the control of time micro-intervals between volleys.

**Special Features of MM physics**

To provide the variety of working media, the dispersing system of MM is supplied with the universal containers filled by various liquids and mixtures. **The ability of MM to complex (or combined) action** can be characterized as its possibility to pulverize the working media of different state, density, dispersibility, viscosity, as well as its rate of fire. **MM action scale** is characterized by size (width and height) of disperse tornado front, and also by area square or volume which is subjected to the tornado of the required concentration and velocity. This scale characterizes the ability of impulse tornado to extinguish the hotbed of fire spread on any area, to protect some objects from the heat flux, to localize the cloud of the active aerosols, and even to neutralize a group of criminals at the given area.

The simultaneous volley from the multi-barreled system realizes its important advantage inherent only in gas – disperse media vortices. Tests confirm that they strengthen one another mutually at their confluence and interaction. Their interaction allows to enlarge the scales of the aggregate vortex action up to 1,5–2,5 times comparing with the arithmetic sum of separate vortices action areas. It is possible to heighten sufficiently the distance of effective total tornado action (up to 4–5 times comparing with the shot from the alone barrel): up to 53 m when the sorbates are working media, up to 120 m at volley dispersion from 10 barrels (20 kg of powder in each of them), up to 60 m at volley water dispersion from 8 barrels (10 liters of water in each). The uniformly moistened area square enlarges correspondingly: up to 450 square meters at sorbate volley from 5 barrels. It is 2–3 times more than the sum of the results of separate actions of the same 5 barrels.

Just for comparison, the volley action of military missiles and shells usually enlarges its subjected area square not more than in 1,5 times comparing with the arithmetic sum of the areas stricken by separate shots. Missile or shell flight distance does not enlarge at volley.



Fig. 2. “Impulse-3M” system with 50-barreled turret MM installed onto the armored chassis of T-62 tank. Each barrel contains up to 20–25 kg of the working mixture. The MM working distance is up to 120 m, the area covered by the only volley is up to 3500 square meters. This “Impulse-3M” can extinguish the gas well with reservoir pressure 140 atm and gas expence 1,2 million cubic meters per 24 hours at one second by the volley from its 10 barrels



Fig. 3. “Impulse-3M” extinguishes 2×200 square meters area where diesel oil burns by the only volley from its 10 barrels

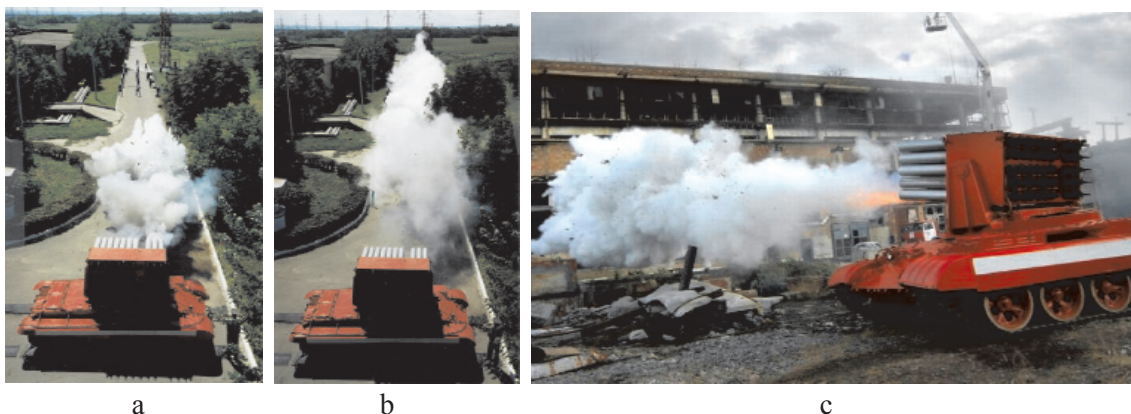


Fig. 4. a – personnel protection from fire, heat radiation: maneuvers with evacuation of volunteers from zone surrounded by flame ring; b – impulse non-lethal influence on presumably terrorist group at guarded area; c – fire hotbed extinguishing in industrial area by artificial vortex through open gates, doors and windows

So we can surmise that the effectiveness of impulse MMs at its volley application can reach the effectiveness of the modern artillery but serves to the solution of the other problems actual in space industry and in our everyday life.

MMs create the gas-dust vortices with wide front surfaces or the gas-droplets tornados. At their interaction with the flame and burning surface, they realize several mechanisms of fire extinguishing. Space scales, uniformity, high power and combined action are the basic

advantages of the impulse fire extinguishing which can reach the quick fire suppression at very small working media expenses (less than 1 liter per square meter). These expenses can not be reached by traditional methods: their typical numbers are 100–1000 liters per square meter when the specialized cars are used, 1–10 liters when the portative fire extinguishers are applied, and 5–50 liters per square meters if the automatic fire-extinguished systems (based on sprinklers, for example) are applied.

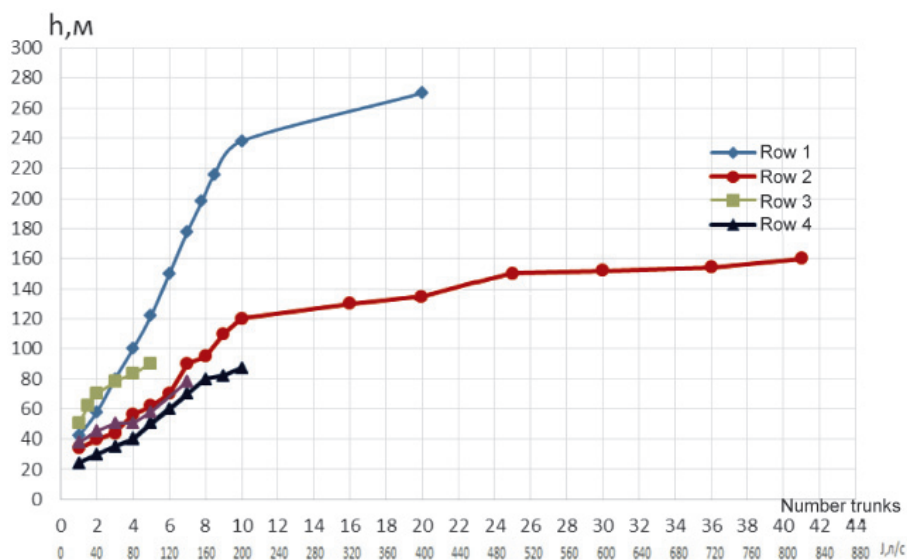


Fig. 5. Dependences of fire-extinguishing powders dispersion distance on the number of barrels at one volley: curve 1 – volleys from the Chinese modified modules (up to 200 kg of the useful powder in one volley); curve 2 – volleys from 50-barreled “Impulse-3M” MMs; 3 – Chinese modified MMs, water dispersion; 4 – Ukrainian MMs working on water; 5 – German two-barreled modules “IFEX-20” (1–4 modules in each volley)

If the gas-powder vortex included special inhibitors, it impedes the burning of fuel because of its influence on fuel radicals. If the tornado consists of gas and water, smoke removal by shock, flame suppression, cooling and destruction of the burning surface are the basic processes. Since a number of volleys and barrels can be large, and their vortices can be concentrated at the same area, the energy applied to fire suppression, or to toxic pollution deactivation seems almost unlimited.

### MM Applications Together with Fire Automatics

For potential fire suppression, MMs can be situated, for example, in protected buildings of nuclear power plant, or in enveloped areas of rocket launch site. As was demonstrated in Dun-Hua field tests (winter 2014–2015), it is easy and cheap to create doubled or trebled covering of the protected area by working media streams.

To diminish the probability of false alarm, the following ways can be used:

- to enlarge the stability of heat and fire sensors due to their optimal structure, their duplication, and introduction of the systems which differs the interference from real ignition;
- to apply the sensors that use the logical circuits which can confirm the authenticity of the ignition message;
- to centralize the stream of information on area and surrounding parameters.

High MM performance can compensate the time loss wasted on the analysis of sensor system.

### Summary

The executive subsystems based of MMs and proposed here is principally new, safe, and universal. It has some qualitative advantages over other subsystems serving for the same goal in fire and rescue service:

- the consumption of the fire-extinguishing media is 10–100 times smaller. That allows the system to work autonomously, using only the working media storages inside MM barrels;
- type, power and scale of the action can be easily regulated, changed and controlled;
- type, power and scale of the action enlarge proportionally to the number of the devices and number of barrels in each device without loss in reliability and effectiveness;
- cost price of system manufacturing and service is very small (a large number of obso-

lete artillery barrels and tanks can change its destination to peaceful one);

- fire extinguishing can be ecologically pure and can help the civil population evacuation;

- high pressure volumes used in these systems are small in size and time of existence (only parts of the second), the firmness of the construction is 10 times higher than the stress-es it is subjected to;

- the system construction is very simple and rather safe in application; gas cylinders, compressors and pumps are not required;

- the useful media dispersion is reliable and stable in the wide range of temperatures (from –50 to +50°C), winds, humidity, dust rates and other climate conditions;

- the secondary blasts of gas, steam, dust and air mixtures are prevented as a rule;

- the rocket fuel pollution onto the launch site area can be localized;

- maximum distance from the flame enlarges up to 10 times; this fact enlarges the safety of firefighting activity and allows the firemen to work from the distances safe in practice;

- there are no restrictions on the state of the firefighting media; we can use dirty, fresh or salty water, sand, dirt, dust and other liquids, gels and foams with various density and viscosity. These media can be found on-site; that allows the long-duration work of MM complex, if it is necessary, without exterior supply.

As a result, the fire-extinguishing systems based on MMs seems to be the best choice for fire safety of rocket launch sites and also for prolongation of launch facilities workability at their severe heating situations.

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## Short Reports

**SEPARATION OF BITUMEN  
FROM MINERAL PART  
OF OILBITUMENE ROCKS  
OF THE WESTERN KAZAKHSTAN**

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In presented work oilbitumene rocks (OBR) of the Western Kazakhstan, of fields Tyub-Karagan Munayly-Mola and Beke were used. For separation of oil-containing part of oilbitumene rocks from a mineral part by of water – alkaline extraction and extraction by organic solvent in Sokslet's device are used. As solvent alcohol- benzene mix was used. The extraction method by organic solvent determined composition of oilbitumene rocks. It is shown that oilbitumene rock of the Munayly-Mola field is more enriched with organic part in comparison with OBR of Tyub-Karagan field. The method of the sedimentation analysis determined the size of particles of mineral part of OBR. It is shown that the mineral part of oilbitumene rocks is polydisperse. The greatest share of particles of a mineral component for system of m of Munayly-Mola has the size of particles of 03–0,38 microns, for system Tyub-Karagan – 0,2–0,25 microns. Research by method of infra-red spectroscopy has been shown that oilbitumene rocks contain saturated and cycloparaffin hydrocarbons, and also existence of CH<sub>2</sub>- and CH<sub>3</sub>- of groups is revealed. The received results showed that oilbitumene rocks of the Western Kazakhstan can be used as a alternative power source to oil.

The international experience shows that oilbitumene rocks can be used for receiving a wide range of valuable products: “synthetic” oil, the liquefied gas, in the paint and varnish and electrotechnical industry, in road construction [1, 2]. Reserves of

oilbitumene rocks in the Western Kazakhstan make 950–1000 million t [3, 5].

OBR are characterized by variety and inconsistency of structure and properties of their initial raw materials. They represent the difficult microheterogeneous disperse system consisting from organic (bitumene) and mineral (sand, clay, firm inclusions with impregnations of metals and oxides, salts) parts. Oilbitumene rocks are multicomponent raw materials, generally this chemical and power.

Content of bitumen and mineral part in rock is unequal not only for various fields, but also for one field on its area and depth. As raw materials for practical use can serve both organic, and mineral components of OBR.

For research in this work oilbitumene rocks of the Western Kazakhstan of fields Tyub-Karagan, Munayly-Mola and Beck were used.

For separation of oilcontaining part of OBR from mineral ways of water and alkaline extraction [4] and extraction by solvent in Sokslet's device are used. As solvent alcoholbenzene mix was used. Results of extraction by solvent in Sokslet's device are given in the Table.

Apparently from the data provided in the table, oilbitumene rocks of Munayly-Mola is more enriched with organic part (16,71%), and the mineral part makes 83.29% whereas at breeds of Tyub-Karagan (14,6 and 85,4%) and Beck Karagan (10,2 and 89,8%) respectively.

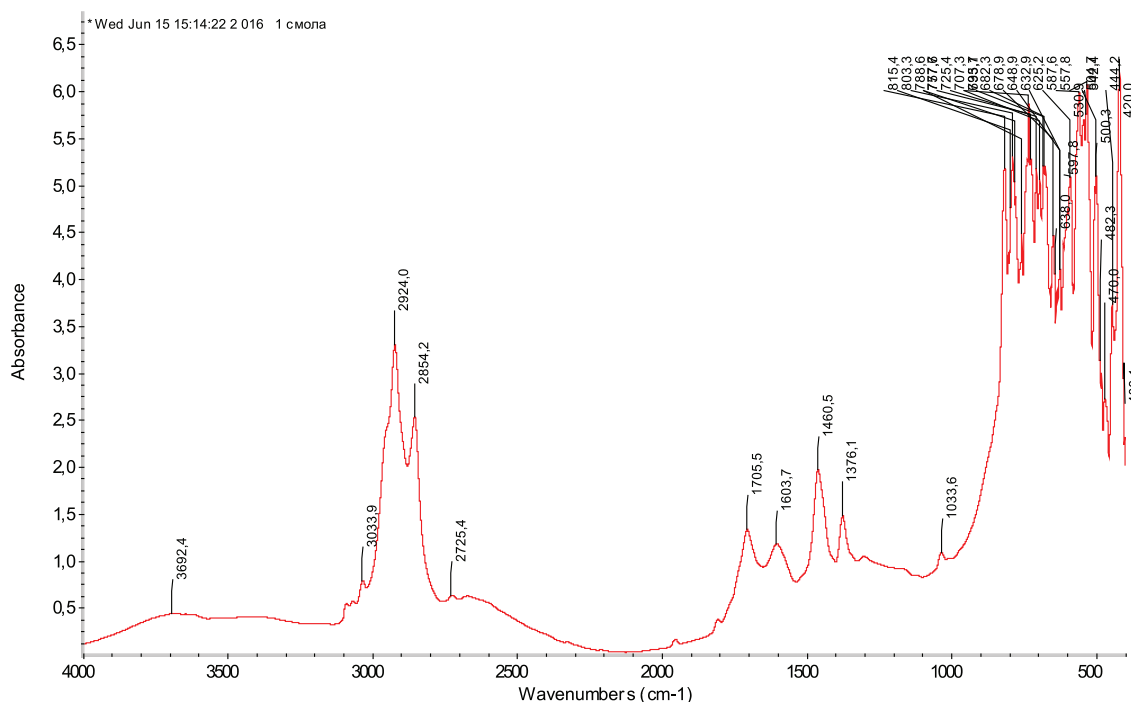
Research of organic part investigated by NBP was conducted by method of infrared spectroscopy. In Figure the IR spectrum, the natural bitumene emitted from OBR of Munayly-Mola is presented.

For all samples of bitumene in the field of 400–2200 cm<sup>-1</sup> of a strip of absorption strips are observed at 425 and 426,9; 471,2 and 485,3; 537,5 and 559,5; 618,9 and 646,8; 705 and 726,8; 882; 911,8 and 925,7; 986,1; 1032,3 and 1042,2; 1070,1; 113,5 and 1125,6; 1218,8; 1236; 1282,6; 1375 and 1376,3; 1453,9 and 1457,7; 1486,4; 1557,9; 1581,7; 1598,3; 1641,6; 1699,3; 1721,5; 1958,1; 2108,2 and 2149,6 cm<sup>-1</sup>.

The composition of oilbitumene rocks determined by an extraction method

OBR	Mass of OBR, g	Maintenance of organic part		Maintenance of mineral part	
		g	%	g	%
1. Tyub-Karagan	50	7,30	14,60	42,70	85,40
2. Munayly-Mola	50	8,35	16,71	41,65	83,29
3. Beck	175	17,86	10,2	157,14	89,8





IK – a range of the bitumen emitted from NBP of m of Munayly-Mola

Very intensive items at 1375–1376,3 and 1453,9–1457,7; 1486,4  $\text{cm}^{-1}$  in oil fractions belong to valent and deformation fluctuations of  $\text{SN}_2$ - and  $\text{CH}_3$ -groups in paraffin and cycloparaffin hydrocarbons. In ranges of all components the absorption strip at 726,8  $\text{cm}^{-1}$  which corresponds to deformation fluctuations of  $\text{CH}_2$ -groups in free paraffin chains is accurately visible.

The disperse structure of mineral part of oil-bitumene rocks of systems was studied by method of the sedimentation analysis. Its principle is based on determination of speed of subsidence of particles of a disperse phase on a cup of the torsion scales and the subsequent establishment of nature of distribution of particles by the sizes and degree of dispersion [6]. In work differential curve distributions of particles by the sizes of three systems of oil-bitumene rocks were constructed.

It is shown that the size of particles of sand for system Tyub-Karagan makes 0,2–0,25  $\text{mkm}$ , for

particles of Munayly-Mola – 0,3–0,38  $\text{mkm}$  and for a sisema Beck – 0,2–0,27  $\text{mkm}$ .

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## ORGANIZATION OF EFFICIENT PROCUREMENT AT THE INDUSTRIAL HOLDING COMPANY JSC «ARCELORMITTAL TEMIRTAU»

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The organization of procurement cargo-material assets in the JSC “ArselorMittal Temirtau”. The algorithm of the process of procurement of material assets of the company. The procurement process has been made possible as a result of the deployment of a unified information system. By means of the created system of the management of internal business processes as well as business processes of interaction with partners is coordinated as a single whole. Documents circulation and budgeting process are optimized, duplication of data is eliminated, accuracy, speed of the account and information interchange are increased.

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**Keywords: procurement organization, commodity – material assets, standards, the algorithm of the procurement process, document**

The field of activity connected with purchasing supposes all functions which performance is necessary for continuous provision of a firm on a daily basis and in the long-term period. Therefore the activity of a purchasing manager includes the following tasks: definition of requirement for material resources; search for a prospective supplier; estimation of possibility of purchasing at several alternative sources; selection of purchasing method; establishment of acceptable price and delivery conditions; monitoring of a product till the moment of its delivery; estimation of supplier's goods and service.

If indeed one expands purchasing functions, inventory control, transportation, acceptance of bought goods and control at all these stages will be related to them.

Basic ends of activity in the area of organization and management of purchasing: optimal terms of delivery of material resources, finished goods and rendering of services. Delay in purchasing can disrupt the production schedule that will entail large indirect expenses, and the materials bought earlier the fixed term become an additional load on circulating assets and enterprise storage rooms; optimal size of delivery lot, i.e. ensuring the exact match between delivery size and requirements in them. Surplus or insufficient size of delivered products negatively influences the balance of circulating assets and stability of production output and, besides, can cause additional expenses at restoration of balance optimum; ensuring and increasing of quality. Goods, materials or services of a necessary degree of quality should be delivered; otherwise a final product will not satisfy the established standards that will lead to growth of logistical costs. Expenses for bringing quality to a standard level can be quite considerable. It is necessary to constantly increase quality of procurement and to provide

competitiveness of the goods and services at world level that requires paying attention to quality of bought materials; search and purchasing of goods and services at floor prices. This problem is urgent for all enterprises as purchasing activity demands great volume of circulating assets, and as experience shows, it is shortage of circulating assets that is one of the main problems of business. The profit received due to purchases at lower prices or owing to reduction of the total logistical expenses, can be very substantial; search for competent suppliers and development of relations with them. The success of purchases of department finally defines reliability of suppliers. The supplier's activity influences productivity, quality and competitiveness of the company-buyer more than the majority of managers fancy. Employee, responsible for selection of supplier, must conduct a thorough search and analysis of possible suppliers. Besides, the analysis should be made by several criteria, for example, by quality of offered products, possibility of timely delivery, price, service etc. Also the important criterion is the risk estimation at realization of purchases; increase in competitiveness of a company. The basic goals of research of the market of purchases consist in regular gathering and estimation of information with the aim of defining of a market capacity and creation of preconditions for optimization of purchases. As the impact to carry out research can become interest to definition of the sizes of expenses, changes in own distribution program, to introduction of achievements of technical progress, increase in a share of a firm at the market, competition, reliability of suppliers, supply size in the future and so on.

Certainly, the purposes of purchasing management differ depending on the specialization (industrial, trading, service) of a firm [5]. The main end of logistical management of

purchasing at an industrial company is reliable provision of industrial divisions of a firm with the material resources necessary for realization of production schedule [4]. The production schedule at that must be formed according to marketing and logistical strategy of the firm at the sale market of finished commodity.

The analysis of potential of increase of economic efficiency of industrial enterprises shows, that about 50% of optimization of financial expenses depend on cooperation with suppliers. While organizing process of purchasing and delivery to a warehouse of manufactured the raw materials the basic part of the cost price of end-product is formed.

JSC «ArcelorMittal Temirtau» is the largest metallurgical company of the world, controlling 10% of the world steel market at the end of 2015. It is registered in Luxembourg. It was formed in 2006 from the merger of Arcelor Luxembourg Company and Indian Mittal Steel, belonging to the Indian businessman Lakshmi Mittal. After the merger production capacities of the company were 420 mln tons per year. The company possesses a great many enterprises for iron ore, coal production and

also metallurgical enterprises including a large «Krivorogstal» plant in Ukraine [2].

The aim of work of department of technical procurement (purchasing) that is subdivided in its turn into bureaus according to kinds of materials and equipment – timely provision of divisions of JSC «ArcelorMittal Temirtau» with materials and equipment of required quality following range appointed to every bureau, according to orders and the business plan.

The kinds of activity of the purchasing department of JSC «ArcelorMittal Temirtau» are summarized in the Table 1.

The ISO 9001–2008 standard serves as a basis for all procedures [1]. The purchasing process is divided into subprocesses and for every subprocess there is a responsible person.

The standards, the norms and the working instructions on each kind of activity of the purchasing department are in the Table 2: normative legal acts, other guiding, methodical materials of higher and other bodies on supplies of materials and machinery; order of making up requisitions for materials and equipment, conclusion of contracts with suppliers, setting of limits on issue of materials and spare parts;

**Table 1**  
Functions, duties and responsibilities by each kind of activity of an engineer of department of technical supply of JSC «ArcelorMittal Temirtau» administration

Kinds of activity	Functions, duties and responsibilities
Provide divisions with necessary equipment	<ol style="list-style-type: none"> <li>1. According to requisitions of divisions to make summary demand for equipment, to prepare documentation for the conclusion of contracts with suppliers in SAP R/3 system.</li> <li>2. To negotiate and be in correspondence with suppliers.</li> <li>3. To prepare documentation for carrying out of customs procedures regarding the received cargoes.</li> <li>4. To prepare receipt documents in SAP R/3 system for acquired equipment and take them to a warehouse to be accepted by a storekeeper</li> </ol>
Control fulfillment of contracts, analyze their economic efficiency	<ol style="list-style-type: none"> <li>1. To ensure timely preparation of documents to claim defaults on suppliers and pass the documents to Legal Department.</li> <li>2. To keep receipt registration books and those of payment for the equipment.</li> <li>3. To verify incoming accounts, provide with an acceptance and submit them for payment in the prescribed manner. To prepare the schedule of payment, pro forma documents for prepayment, bills of credit</li> </ol>
Keep account of material resources and make reports.	<ol style="list-style-type: none"> <li>1. To participate in acceptance of cargoes by quantity and quality.</li> <li>2. Make out receipt by statement of fixed assets by OS-1 form with the appendix of a card of the account of the fixed assets with description of total characteristic.</li> <li>3. To keep inventory tags. To keep up warehouse stocks at the fixed level.</li> <li>4. To take part in the commission to make an inventory. •</li> <li>5. To prepare data for the statistical reports</li> </ol>
Observe the labor discipline and house rules	<ol style="list-style-type: none"> <li>1. To follow instructions of the immediate supervisor.</li> <li>2. Not to divulge commercial classified information of JSC«ArcelorMittal Temirtau».</li> <li>3. To fulfil requirements of the acting quality management system at JSC «ArcelorMittal Temirtau».</li> <li>4. To observe house rules</li> </ol>

keeping records management of purchasing operations; standards, technical specifications, price-lists, range of used equipment, spare parts, products and consumed materials; basics of technology, economy and industrial engineering; basic of labor legislation; regulations and norms of labor protection and of fire safety.

There is the uniform system for making annual and operational planning, purchases, management of warehouses, and movement of materials is also controlled within it. At that, at all stages of planning and carrying out of project in on-line mode it is possible to get analytical reports at various combinations: company – project – measure – expenses – plan/fact that allows correcting strategy flexibly.

Realization of these approaches became possible as a result of expansion of the uniform information system consisting of the portal solution of SAP Company, registration systems on base IS and creation of mutual directories of materials, contractors, divisions, budget addresses and units of financial management for the whole company. Uniform protocols of integration are used for the whole company: the portal solution, introduced in the main company office, is integrated with systems of shops of the enterprise by the common scheme. Thus, the system becomes easily scalable: whatever many new divisions would appear, the accurate and reliable algorithm for integration is always used.

Thus due to the centralized keeping the reference data, nomenclature documents for the main company office and all its shops and dependent structural divisions (automatically updated directories “sew in” in their registration systems), continuous numbering of documents so data in all registration systems always correlate with each other. As a result each document has the history of appearance (requisition, plan etc.) which can always be traced. All this ensures uniform structure of work of divisions and practically completely excludes influence of the human factor on quality of the data stored in the system.

By means of the created system of the management of internal business processes as well as business processes of interaction with partners is coordinated as a single whole. The system promotes creation of a uniform information field. Documents circulation and budgeting process are optimized, duplication of data is eliminated, accuracy, speed of the account and information interchange are increased.

The process of annual planning of material support consists of several basic stages: formation of measures; preliminary and finite requisition campaigns; making and correction of material support plans. At that annual planning is realized as uniform continuous process from the appearance of need till its write-off. Virtually all divisions of the company are involved in it: material and technical departments and purchasing department, participants of process

**Table 2**

The standards, the norms and the working instructions by each kind of activity of an engineer of department of technical supply of JSC “ArcelorMittal Temirtau” administration.

Kinds of activity	The standards, the norms and the working instructions
Provide divisions with necessary equipment	decrees, arrangements, orders regarding JSC «ArcelorMittal Temirtau»; approved business plan; quality policy, JSC «ArcelorMittal Temirtau» quality manual, enterprise standards and other documents of quality management system; Incoterms 2000
Control fulfillment of contracts, analyze their economic efficiency	instruction about the organization of export and import currency exchange regulation in the RK; Incoterms 2000
Keep account of material resources and make reports	results of checks of internal and external audit; Incoterms 2000; established order of keeping and preparing of documentation; established order of work according to SAP R/3 system; order of issue of equipment to JSC «ArcelorMittal Temirtau» divisions
Observe the labor discipline and house rules	regulations and norms of labor protection, of safety measures, of industrial sanitation and of fire protection; established order of circulation of documents, containing information being commercial classified one of JSC «ArcelorMittal Temirtau» – house rules; instruction about access and in-plant control at JSC «ArcelorMittal Temirtau»

of planning and realization of a production program, of capital construction, of maintenance works and repair of the equipment', of investment projects, of the account and control of deliveries and of transfer of inventories. As a basis of planning there is a measure due to it addressness of each logistic process is achieved.

It means the following. Activity of all functional units in the company is considered from the point of view of realization of individual project in the specified terms. Each of them consists of a certain list of the measures which carrying out will allow realizing the project and thus to reach assigned goals. For example, as measures can be programs and subprograms of activity of divisions. So, for divisions of capital construction they are projects under construction and their subobjects. Thus each measure must be related to needs of capital construction, or to repair and maintenance needs.

Structural divisions and service enterprises form requisitions of primary requirements (annual requisitions) for inventories with linkage to measures and detailed description up to a concrete material or equipment with layout per months. The formed annual requisition is submitted for approval by the main specialist, then the summary requirement is formed and coordinated by all main specialists and further on by upward chain the need of the whole company. Coordination of the summary needs is done according to the register of requisition.

The system of authorities differentiates access to requisitions. Structural divisions have no access to the information regarding other structural divisions, and the main specialist – to the information about other main specialists. The superior employee additionally has access to the information of the junior ones. On the basis of the approved annual requisitions the planning and budgetary division forms the plan of write-off of materials and directs it to division on supplies of materials and machinery where the plan of financing of acquisition of inventories is automatically made.

All purchases of the company it is possible to divide into two groups: centralized purchases which are carried out according to a business plan, and decentralized, or one's own, purchases of divisions on supplies of materials and machinery on the basis of requisitions.

At the centralized purchasing after approval of the plan of material support the positions grouped by groups of purchases are sent to the central purchasing division of the main company office of JSC «ArcelorMittal Temirtau» for processing. Having received the register of orders the manager processes the positions

whether there are any at the market and if it is possible to buy them.

On the basis of the received requisition for a material, the manager of purchasing department makes a list of possible suppliers consisting of constant suppliers which long-term cooperation contracts are concluded with, and, probably, new, revealed by means of various information channels, including as a result of the analysis of some earlier received offers. Further one prepares the inquiry about the material which represents a request to the supplier to deliver the material, the identifier, needed quantity and terms of delivery are specified in corresponding positions of the inquiry form. The inquiry prepared and completed in appropriate way is coordinated with the head, and in case of need, corrections are made in it. The inquiry prepared and completed in appropriate way is sent to possible suppliers via e-mail.

At reception of commercial offers from possible suppliers their registration is made in the prescribed manner. Prices and delivery conditions of possible suppliers are registered to corresponding inquiry. For the registered offers a list with comparisons of prices and delivery conditions is made. If there are some questions about received commercial offers from possible suppliers the coordination by positions requiring explanation or additional information is made.

Further a tender takes place. The selection of the most suitable suppliers is made on the basis of the list with comparisons of prices and delivery conditions for the registered and approved commercial offers from possible suppliers, the presence or absence of long-term contractual relations with them at present, and also on the basis of the additional information on the company – the possible supplier. The selection of supplier and conclusion of contract with him is made on the basis of JSC «ArcelorMittal Temirtau» pricing policy. The notice for the supplier on inclusion in the system of the delivery order is done automatically by e-mail with the subsequent placement of the filled requisition form for payment to the repository of documents.

The information about material receipt initiates in the system accounting transactions regarding the debit of the account of reserves and the recalculation account credit, thus, quantitatively increasing a material stock. Together with receipt of materials the entering lot of material with classification of signs of the lot (receipt date, activity direction, etc.) is created. Processes of moving to structural divisions, write-off of materials to shops and the contract enterprises, and also gathering of actual expenses are also fixed in system.

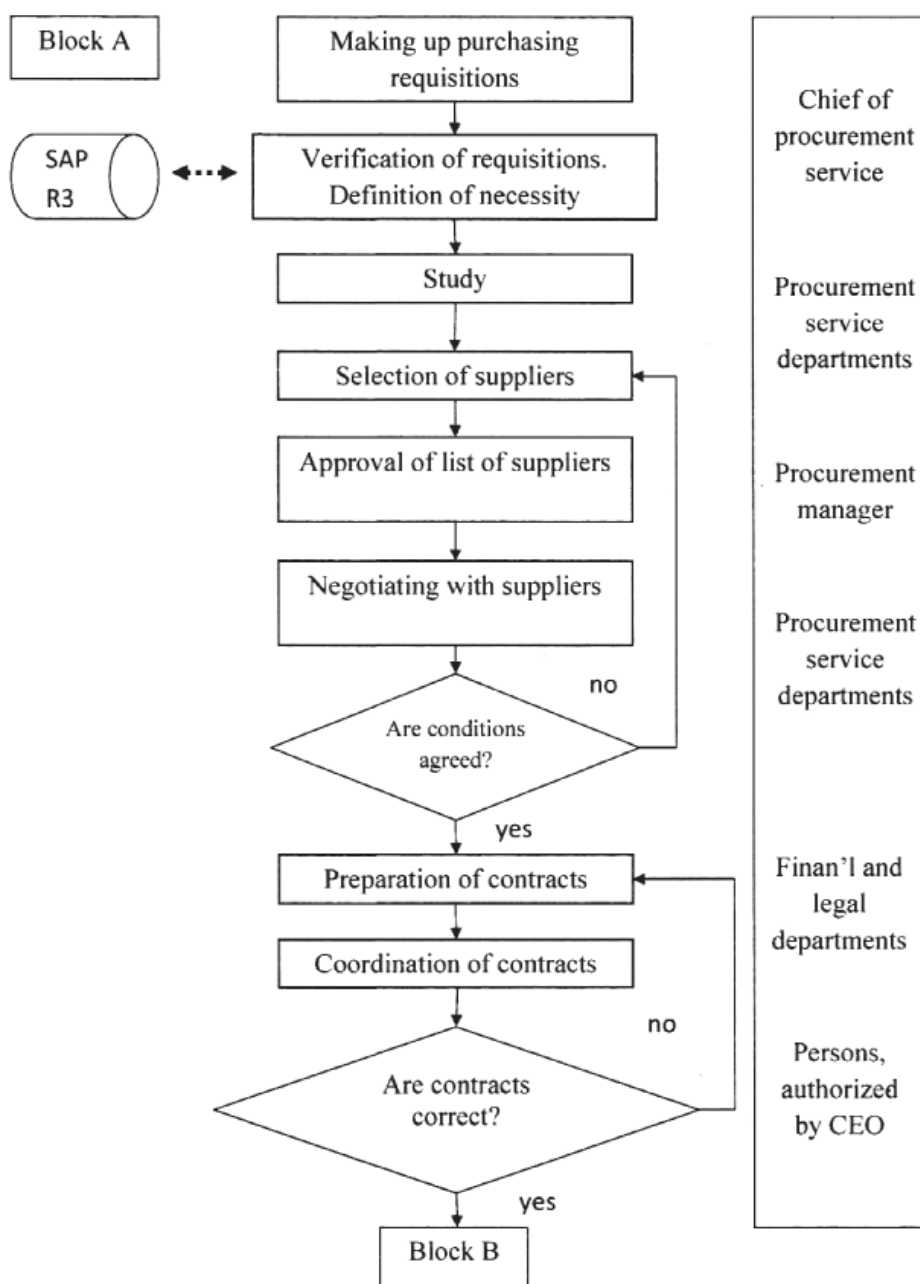


Fig. 1. The algorithm of the process of carrying out of purchasing of material means

The reason to make payments is an invoice of the supplier (the latter is created in its turn on the basis of a delivery order). For unpaid invoices assigns for payment are formed. Thus in the system accounting transactions for the debit of the recalculation account and the credit of the account of the supplier, and also transactions for the entering VAT are carried out, the account payable is formed. The given mechanisms allow organizing uniform cost and quantitative account of reserves of materials in a real time mode.

The uniform system of supplies of materials and machinery management is integrated with subsystems of warehouse management, of planning and calculation of inventories. At that in the system real receipt of commodity positions and their location at warehouses are reflected. And while carrying out the next purchasing campaign it is possible to use effectively unclaimed residues of inventories, thus having reduced volume of the means spent for materials and equipment acquisition.

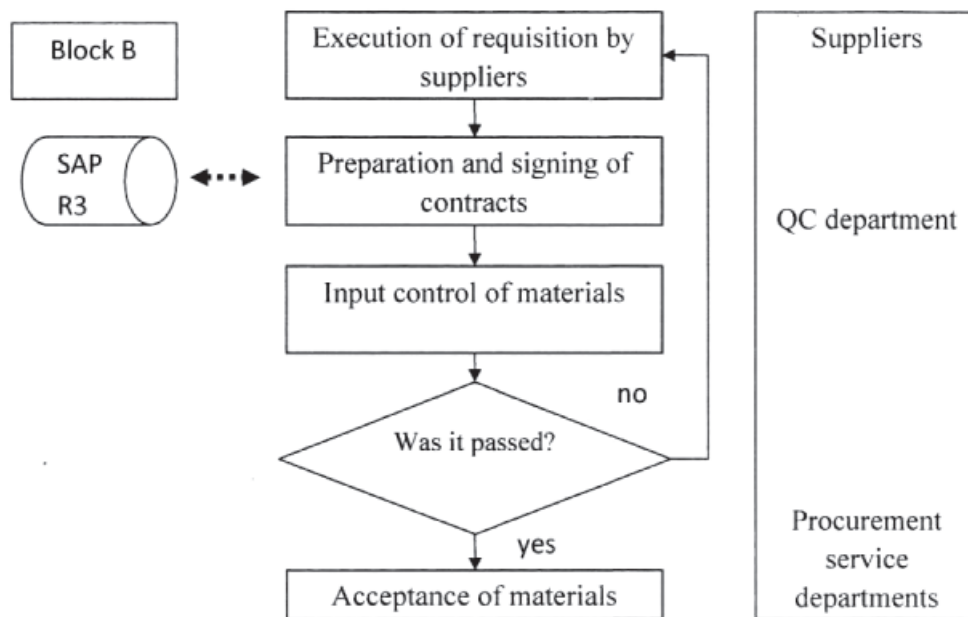


Fig. 2. The algorithm of the process of carrying out of purchasing of material means

The documents circulation concept installed in the system includes the whole “life” cycle of a contract from the moment of its creation till write-off of a product. Due to it mismatches between financial and logistic operations are eliminated, possibility to plan payments, delivery terms and works by contracts appears. All work on a contract is done in electronic form. For storing and searching for necessary documents (including scanned ones) the common register and archive of contracts are kept, and also common directories of contractors, materials, financial positions and units of financial management function for the whole company.

An analytic component allows constantly controlling and analyzing routes passed by documents as well as payments and budget performance at conclusion of contracts etc. Besides the system accumulates statistics and allows preparing reports: on carrying out of the contracts, on documents regarding purchasing contract, on budget performance including that of divisions.

The efficient management of purchasing process is impossible without receiving regular and reliable analytic reports. Within the limits of the common system there are different forms of reports within the framework of each stage of management process. So, as to reserves management there exist such kinds of

reports, as dynamics of unclaimed and illiquid property, regarding residues of inventories, dynamics of their movement for some period, on receipt and realization of inventories for some period. It enables to control daily purchasing process and instantly receive the information necessary for management of the given process and making decision on its optimization, and also effectively to realize such functions, as the control of payments and quality performance of contractual obligations. Moreover, there is a possibility to control budget performance, to analyze correctness of business accounting.

The algorithm of the process of carrying out of purchasing of material means by JSC «ArcelorMittal Temirtau» company is represented as a following scheme that is shown at Fig. 1 and 2 [3].

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## A STATISTICAL APPROACH TO ANALYZING THE EFFICIENCY OF AGRICULTURAL PRODUCTION: THE EXAMPLE OF CENTRAL RUSSIA

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The article presents the analysis of indicators of agricultural output in Central Russia during the period from 2000 to 2014. Time series of output in current prices are approximated by exponential model and evaluated by the method of least squares (estimated value of production output in 2014 and its rate of increment). The dynamics of the consumer price index of agricultural production in the Central Russia can be as well analyzed by exponential models and their estimations. The increment rate of agriculture output and the CPI correlate negatively. The agricultural producer price index can therefore be a valuable indicator of the regional rural economy level.

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**Keywords:** regions of the Central Federal District, agricultural production, agricultural output, time series, current prices, exponential models, least squares estimation, consumer price index, increment rate, correlation

The following article discusses the issue of statistical analysis of agricultural economics of the Central Federal District (CFD) in Russia. Value index of agricultural production expressed in current prices serves as basis indicator. Data on the regions of the CFD over the period of 2000–2014 published in statistical collections of Rosstat is the empirical basis, whereas the SPSS software Base 8.0 for Windows is a toolkit for the analysis [1].

The question of agricultural efficiency is a subject for many an articles. For instance, the publication [3] has a review of studies on the theme and clarifies a set of questions and problems dealing with efficiency growth in the agrarian sector of Russian economy. In [2] the authors highlight the overall importance of quality methods and complex researches in the field of actual agricultural economics. Thus the significance of precise agricultural output estimation is a concern of a vast number of authors, so that factor defines the high level of actuality of the theme of agricultural efficiency.

This research logically continues the article [7] and develops the study proposed in it. The present article is based on the analysis of panel data, i.e. spatial selections presented in a form of time series. Analysis of this type of data is of remarkable interest, because it allows us not only to estimate growth rates of agricultural output, but also to perform a regional comparison. We decided to use the innovatory methodological approach for analysis of panel data proposed in [6], which has the following stages:

1) organization of time series of three indicators (agricultural production value index, consumer price index (CPI), and agricultural output index, further referred as indicators 1, 2, and 3 respectively) for all the regions of the CFD over the period of 2000–2014; this lets us analyze the time impact and tendencies;

2) approximate the panel data with the help of two-parameter models (exponential, hyperbolic, parabolic ones according to the character of indicator's dynamics);

3) use the OLS-estimations of the parameters of the aforementioned models for further analysis of dynamics in different regions, thus analyzing the spatial tendency. Such type of approach saves the visibility, which is crucially important for an adequate analysis of efficiency, and hence it is an appropriate method of analyzing the processes of agricultural output in other regions.

We aim to verify if the following models can be used for analysis of agricultural production efficiency, so an analysis of the regions of the CFD has been performed as an example for the approach.

The dynamics of agricultural output expressed in current prices are characterized by accelerated growth. This pattern of dynamics corresponds to an exponential model

$$AO = b_0 \exp(b_1 t), \quad (1)$$

where AO stands for agricultural output, and  $t$  – a time variable. This model can take non-positive values of the time variable, so as far as we are interested the indicator's value of the final year of the time span (2014), we define the time variable as follows

$$t = \text{year} - 2014. \quad (2)$$

According to (2), the final year of the analyzed period corresponds to the value  $t = 0$ , thus we can interpret the parameter  $b_0$  as the estimated value of production volume in 2014, and the parameter  $100b_1$  – as the average annual increment rate.

The results of approximation of dynamics of agricultural production value index, consumer price index, and agricultural producer



price indices in both the Central Federal district and the Russian Federation by exponential models are demonstrated in the Table, where they are represented by their OLS estimations. Furthermore, all the three indicators have similar dynamics; this fact confirms the adequacy of the prerequisite for using them for analysis.

dency. Among the other regions Bryansk, Kaluga, Oryol, and Ryazan oblasts have the increment rates close to national average. Thereby we can distinguish and characterize six typological syndromes (term and concept proposed by mathematician and sociologist G.G. Tatarova [8]).

Parameters of exponential models of dynamics of agricultural production value index (indicator 1), fixed base consumer price index (indicator 2), and fixed base agricultural producer price index (indicator 3) over the period of 2000–2014

Region	OLS-estimation of the indicator 1		OLS-estimation of the indicator 2		OLS-estimation of the indicator 3	
	Calculated value in 2014, mln RUB	Increment coefficient	Calculated value in 2014, %	Increment coefficient	Calculated value in 2014	Increment coefficient
Belgorod obl.	209016	0,1928	489,7	0,0568	3,66	0,0841
Bryansk obl.	46246	0,1239	527,3	0,0638	3,90	0,0856
Vladimir obl.	32456	0,1064	504,5	0,0616	5,44	0,1146
Voronezh obl.	158312	0,1602	477,5	0,0549	5,20	0,1089
Ivanovo obl.	15900	0,0968	524,3	0,0659	4,80	0,1039
Kaluga obl.	33418	0,1198	542,9	0,0695	4,90	0,1064
Kostroma obl.	19572	0,0922	507,6	0,0637	4,37	0,0949
Kursk obl.	88319	0,1464	548,4	0,0551	5,37	0,1138
Lipetsk obl.	76532	0,1444	482,4	0,0544	3,75	0,0877
Moscow obl.	106181	0,1047	505,9	0,0588	4,57	0,0970
Oryol obl.	48645	0,1248	453,6	0,0622	5,80	0,1241
Ryazan obl.	45003	0,1180	497,0	0,0641	4,94	0,1117
Smolensk obl.	22337	0,0958	543,4	0,0619	5,84	0,1213
Tambov obl.	82650	0,1564	462,9	0,0610	3,58	0,0846
Tver obl.	25318	0,0853	479,6	0,0592	4,69	0,1042
Tula obl.	42512	0,1043	543,3	0,0628	4,46	0,1012
Yaroslavl obl.	28698	0,1040	531,8	0,0652	4,14	0,0928
RUSSIA	4456340	0,1254	475,2	0,0614	4,84	0,1056

All the exponential models of the first indicator are characterized by high values of quality criteria: they are adequate (statistical significance of  $F$ -test does not exceed 0,0005) and explain from 93,6 to 99,1% of common variance. The parameters of the exponential models of agricultural productivity correlate positively, the Pearson sample correlation coefficient  $R = 0,864$  is statistically significant on the  $p$ -level  $< 0,0005$ .

The trend shows that the parameters of the models change proportionally to each other. Against this background that three regions are excelling from the others – Belgorod, Voronezh, and Moscow oblast have leader places in rankings by both parameters. Kursk, Tambov, and Lipetsk oblasts belong to the regions of the prevailing ten-

Further study of the regional groups was performed with hierarchical cluster analysis (HCA) with the Ward's method with squared Euclidean distance and  $z$ -scores of the variables [4]. There are six clusters on the level of similarity 95%, three of them comprise one region (Belgorod, Voronezh, and Moscow oblasts), while the others are identical to the aforementioned typical syndromes. Iterative  $k$ -means cluster analysis with  $k = 6$  (a number of clusters) showed two discrepancies (for Vladimir and Tula oblasts). Nevertheless, these discrepancies are minor, and relation «match/mismatch» is equal to 15/2, so that it is possible to accept the results of hierarchical cluster analysis.

It is noteworthy that the scatter of average annual increment rates of agricultural output is considerable (minimum – 8,5% in Tver oblast,

maximum – 19,3% in Belgorod oblast). Even if the truncated series is analyzed (without the leader – Belgorod oblast), the coefficient of variation is equal to 19,8%. This fact indicates the high information level of the parameter.

The above-mentioned in Table estimations of average annual increment rates of agricultural output expressed in current prices include an inflation impact; therefore it is necessary to compare them with those of inflation indices, which notably differ in regions. In the publication [5] discussing the analysis of inflation processes in Central Russia, a relatively high variability of regional inflation indices was revealed: coefficient of variation of food component was equal to 4,7%, that of non-food component was equal to 9,0%, and that of tariff component – to 13,4%; whilst the overall coefficient of variation was equal to 5,0%.

These estimations refer to the period of 2008–2011, whereas the study of dynamics of agricultural output in the CFD regions covers the period to 2014, thereat the modeling of base inflation indicator – consumer prices index (CPI) – has been prolonged for the period from 2000 to 2014. The following stages have been performed for the modeling: firstly, the chain indices of inflation process (in percentage to December of the previous year) were substituted by the fixed base indices (in percentage to December of the basis year, 1999), thereafter the time series were approximated by models of the same type.

The dynamics of chain CPIs for the Russian Federation is clearly cyclical: during the period 2000–2006 inflation was decreasing by about 10% in total, then it was growing to its local maximum in 2008, afterwards it was again decreasing up to 2011, after a period of stability from 2011 to 2013 a new cycle of inflation growth began.

The dynamics of time series of fixed base inflation indices is more «smooth», their cycle changes are expressed correspondingly to the rates of change of the indicators. In consideration of the characteristics of dynamics of fixed base CPIs, the authors accept the time span 2000–2014 for the modeling.

During the process of modeling with the statistical procedure *Curve Estimation* of the software *SPSS* we found out that the dynamics of base CPIs over the period 2000–2014 could be described with high degree of precision by exponential models: the coefficient of determination demonstrated that the models explained from 98,1 to 100,0% of common variance, statistical significance of *F*-test (*p*-level) of all the models is not more than 0,0005 (with

the exception of a model for Voronezh oblast, which's *p*-value is equal to 0,001). The coefficients of these models can be seen in the Table (indicator 2).

All the exponential models are adequate, they explain from 98,1 to 100,0% of common variance. This lets interpret the parameter  $b_0$  as the estimated value of consumer prices in 2014 (in percentage to December 1999), and the parameter  $100b_1$  – as the average annual inflation level.

The analysis demonstrated the high level of variability of the indicators: inflation rate varied from the minimum value 5,44% in Lipetsk oblast to the maximal one 6,95% in Kaluga oblast; CPI – from the minimal 453,6% in Oryol oblast to the maximal 548,4% in Kursk oblast.

The obtained results make it possible to correct the previously calculated estimation of the average annual increment rate of agricultural output in the regions of the CFD. It is clearly seen that considering of inflation process hasn't affected the regional agricultural output ranking – meanwhile leaders and outsiders remained the same, several ranks were changed only in the middle of the ranking list of the regions.

Comparison of average annual agricultural output increment rates with consumer price indices in the CFD regions shows a negative dependence of the ranks – if inflation rate grows, increment rate of agricultural output decreases. This tendency is verified by correlation analysis: there was a statistically significant correlation between the two indicators with the Pearson sample correlation coefficient equal to  $R = -0,642$ .

The article [5] discusses territorial consumer price indices on the example of the CFD and indicates that they are mainly influenced by food component, secondly – non-food component, thirdly, CPIs are defined by changes of tariffs and service costs. Non-food and goods inflation is also defined by producers' prices of agricultural production, so that it is important to analyze the dynamics of producers' prices of agricultural production in the regions of the CFD.

The similar method of analysis is used for the period 2000–2014; firstly we calculated fixed base agricultural producer price indices, then performed an approximation of the time data with the procedure *Curve Estimation* of the software package *SPSS*.

Time series of fixed base agricultural producer price indices both in the regions of the CFD and in Russia over the period

2000–2014 can be approximated by exponential models (1). Their OLS-estimations are shown in the Table (indicator 3).

All the exponential models of dynamics are adequate and statistically significant on the  $p$ -level  $< 0,0005$ ; they explain from 94,4 to 98,6% of common variance. This lets us interpret the parameter  $b_0$  as the estimated value of base agricultural producer price indices in 2014 to the level of 2000; the parameter  $100b_1$  – as its average annual increase rate.

The next part of our study is the analysis of spatial tendencies and comparison of the models' parameters with the regions of the CFD serving as the units of analysis.

The ranking of the CFD regions according to the parameters of exponential models of agricultural producer price dynamics and its increment rate unveiled a positive correlation between the two parameters. Belgorod, Tambov, Bryansk, Lipetsk, Yaroslavl oblasts are the leaders in both rankings (price index and its increment rate), and, opposite to them, Oryol, Kursk, Smolensk, and Vladimir oblasts are characterized by notably lesser level of dynamics of these indicators. If we compare the rankings by producer prices growth and by rate of increment of agricultural production, we can notice a negative correlation (the less is the level of producer prices, the more is its increment rate).

However, correlation between these parameters appears only as a tendency: the Pearson sample correlation coefficient  $R = -0,339$  is statistically significant on a one-tailed  $p$ -level equal to 0,092 (or 9,2%), consequently the risk of accepting this tendency as a statistically significant fact exceeds the normative barrier of 5%. It is more soundly to identify the re-

gions according to the parameters of financial indicators. It can potentially be performed by comparison of the marks of a region with that of the national level.

From the conducted research on the example of the CFD we deduce the fact that agricultural producer price indices estimated with the help of the proposed methodology can be employed as an indicator of the level of regional agriculture management. The analysis of other regions with this model will be the subject of our forthcoming publications.

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## HEURISTIC APPROACH TO THE FORMATION OF THE STUDENTS' POLY CULTURAL PERSONALITY ON THE DISCIPLINE "RUSSIAN AS A FOREIGN LANGUAGE"

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The article discusses the various stages of formation of multicultural linguistic personality (the primary language personality, secondary language personality, bilingual identity, multicultural identity), which is formed in the conditions of modern Belarusian higher education. The author defines the key concepts of the study. The aim of the introduction is the possibility of correlating the stages of formation of the polycultural personality, model of heuristic dialogue groups and levels of learning Russian as a foreign language. The correlating model of the stages of identity formation, the model of heuristic dialogue groups and levels of learning Russian as a foreign language is shown in the main part. This formation takes place on the basis of primary linguistic personality, as this person that speaks his native language from birth. Secondary language personality can be formed on the basis of primary linguistic personality – a personality that studies a foreign language outside the language environment. When the secondary linguistic personality is adjudged to be in an alien language environment it would be formed of bilingual linguistic personality, i.e. personality, fluent in their native and foreign language. To go to the level of multicultural identity requires that the identity adopted (interiorservice) not only the language, as a structure, but also the culture of other people. The author shows that the development of different types of linguistic identity in accordance with the structure of the heuristic dialogue significantly increases the efficiency of studying the Russian language students, develops independence and creativity of students to continuously break new ground, to create their own "educational product". Work organized in such manner is directed on realization of principle of humanistic education.

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**Keywords:** communicative competence, heuristic dialogue, educational product, language personality, language level, bilingual, secondary language personality, multicultural personality

The area of expansion of the Russian language is the widest of all Slavic languages in Eurasia. The teaching in higher education institutions of the Republic of Belarus is conducted, as a rule, in the Russian language, so the studying of Russian as a foreign language is very important. The studying of Russian became an effective tool in addressing one of the strategic objectives of higher education of the Republic of Belarus. It is the export of educational services. Therefore, improving of the quality of teaching Russian as a foreign language in institutions of higher education is a priority of modern higher education in Belarus.

Actual demands reflect the trends of world development with their integration in the field of modern language education. They are the unification and multiculturalism of education and training, the aims at the introduction in higher education, the linguistic pluralism, the inclusion of students in the dialogue of cultures in the process of languages and cultures learning, the achievement of European standards [1]. All these processes are inextricably linked with the formation of linguistic identity. The phenomenon of linguistic identity in modern linguistics has science categorial status. G.I. Bogin give one of the first definitions of linguistic identity in the book "The contemporary linguodidactics": "the central concept of linguistics is the linguistic personality. It is a person, considered from the point of view of its readiness to produce speech acts". Linguistic personality is the person who assigns the

language. Linguistic personality is characterized not so much by the fact that the person knows about the language, as the fact that he produces by the language" [2, p. 3].

### The purpose of research

The quality of teaching of discipline "Russian as a foreign language" can be diagnosed through the communicative competence, which we developed in foreign students. However, communicative competence is not so much a purpose as means of formation of the polycultural personality. The formation of such a personality goes through several stages:

- 1) formation of **primary language personality**;
- 2) the formation of **secondary language personality**;
- 3) the formation of **bilingual personality**;
- 4) formation of the **polycultural personality**.

All these stages are interrelated and cannot exist one without other. Let us consider each stage in the formation of a language personality:

1. The **primary language personality** is a person formed in its native environment and talking in its native language. The foreign student who to study at the universities of the Republic of Belarus, already fully formed as a primary language personality in its linguistic environment. The formation of a primary language personality starts with the birth and development in native language and culture environment.

2. The **secondary language personality** is the person or language learners outside the language and foreign environment. Foreign student coming to Belarus for higher education, has been formed as a secondary language personality. This is because the majority of the students study Russian language at home and arrive with some knowledge on the structure of the Russian language and at least a minimum stock of vocabulary. G.I. Bogin determines the secondary language personality, the first, as a structural replica of the primary linguistic identity. The second, he believes that it is the original and planned portrait of a language personality. It is obvious that in approaching the learning process in one or another study group, the teacher should be able of testing a baseline portrait of each language personality of the student, and then the portrait he plan to create, i.e. a language personality, which would to be formed as a result of the course [3]. Modern linguistics, following N.D. Holschova and N.I. Gez, consider secondary language personality as a result of education in foreign languages secondary language personality as an indicator of a person's ability to participate fully in intercultural communication [4] and understand the secondary linguistic personality as "the set of abilities to foreign language communication into thee intercultural level, which is in adequate interaction with other cultures" [5, p. 59]. Components of this personality are:

- acquirement of the "language picture of the world" speakers of this language (i.e. verbally-semantic code of studied language),
- acquirement of the "global" (conceptual) view of the world, allowing a person to understand a new social reality [5].

There are a lot of questions not yet developed by linguodidactics. First of all it is necessity of introducing some relevant to this field of knowledge terms [6], according to various researchers. We want to give the following definition: secondary language personality is a person who studies a second language outside the language environment and is able to accept and create messages in a foreign language but have not mastered all the subtleties of the language.

3. **Bilingual personality** is a person which has fluent in the native and foreign language experience. Bilingualism is defined as the ability to build solid remarks in two languages or as the practice of alternately using two languages. A person can use to communicate two language systems. The concept of bilingualism is now included possession of three, four, five, etc. languages. According to foreign linguists,

the addition of third, fourth, fifth, etc. language does not change the nature of the problems posed by bilingualism [7, p. 36].

The formation of bilingual identity can be traced through the verbal behavior. Verbal behavior generally reflects the national-cultural specificity, which is conditioned by traditions, customs, aesthetic tastes of a people [8, p. 51]. Students which study Russian as a foreign language have all the prerequisites for becoming bilingual because they learn not only foreign language but also the culture. Development happens not only in the classroom of foreign language, but also spontaneously, continually, since the students are constantly into the other language and cultural environment. Therefore, we consider in our study such foreign students receiving higher education in a foreign country and into the language environment. This circumstance, in our opinion, contributes for the formation of the "student media in one language (multiple languages)" or a "bilingual student". We give the following definition of the bilingual person "it is a person who studies a second language in the language environment. He is able to create and receive messages in a second language and have mastered all the subtleties of the language, but he hasn't internalized into another culture".

4. **Multicultural personality** is a person who did not only speak foreign languages, but he is involved into culture. Formation of the polycultural personality is seen today in the context of the dialogue of cultures. "When a foreign student must learn to interpret the different cultural values that will allow him to continue his education abroad, to see in another's not only what distinguishes us from each other, how many, what brings us together and unites, to look at events and their participants not from his point of view, but from the perspective of another culture, to correlate existing stereotypes, perceptions of experience and to make adequate conclusions, i.e. to understand another's reality; to empathize, to respond to the events of reality, to feel joy and pride, compassion and desire to help; glad that you learned something new in a foreign culture in the process of exposure to a foreign culture" [9].

The implementation into intercultural communication is necessary to gradually eliminate the so-called "strangeness" in the minds of the trainees and puts it into the category of secondary, but "not-another" language, "not-strange" culture [10, p. 277]. In other words, the individual "grows" into a foreign culture, becoming a person differing from other species by the

presence of processes of conscious and arbitrary mental activity. As already proven in linguistics, and in psycholinguistics in particular, the program of self-development recreational abilities inherent in human beings [11, p. 384]. So, from our point of view, the multicultural individual is a person fully studied second language in the language environment, mastered all the subtleties of the use of language, as well as interiorized service a different culture with all its subtleties and peculiarities.

### The results of the study

We believe that the stages of formation of linguistic personality are correlated with the structure of the heuristic dialogue and the levels of learning the discipline "Russian as a foreign language". The concept of heuristic learning that contributes to the formation of the structure of the heuristic dialogue consists of three questions: "What? How? Why?". This triad of questions determines the stages of work. Data model groups relate to the stages of formation of the polycultural personality and levels of competency in discipline "Russian as a foreign language" when working on the subject. The system construction corresponds to the methodology of heuristic learning. Stages of studying of the Russian language and the transition from one stage of formation of the polycultural personality to another are determined by the triad contained in essence of the heuristic dialogue.

1. The model group of questions "What?" or the step of secondary language personality forming. The model group of questions "What?" suggests that the student learns the investigated area of reality and describes the properties of the object [12, p. 11]. When students begin to study Russian language, while working on the stage, "What?", i.e., internalize "the thematic, situational, communicative-speech and language topics into the program of teaching Russian as a foreign language, which regulates the basic content of a threshold level of communicative competence. The mastery of linguistic, speech and communication material signals the achievement by the foreign students basic starting level, which is necessary to continue training in higher educational institutions of the Republic of Belarus in their chosen specialty [13]". The work of the group "What?" is aimed at predicting the content of the text and phonetic and lexico-grammatical difficulties removal. New words are introduced and secured on this stage (in any subject you can find enough complex vocabulary), the functional types used in the text statements are

analyzed, previously studied lexical and grammatical material is checked. Special attention is paid to tasks on the questioning. It should be noted that this stage ends with the creation of students' primary educational product, for example, students' created questions and dialogs. An example of such tasks may be "Web-interview": *Jules Verne has earned the reputation of a brilliant science-fiction writer. Today he is called the seer. In fact the scientific predictions of the Frenchman being fulfilled one after another. A lot of his invested things came to our lives, for example, spacesuits to stay under water, helicopters, automatic rifles, electric vehicles, submarines, televisions, phones and much more. Write down at least 5 questions for the interview with Jules Verne. Try to put yourself in the place of the great science fiction writer. What's up with you? Think about what questions could ask you a writer?*

We propose in the first stage to use the following types of tasks: "Web-dialog", the tasks in goal-setting and planning work, tasks for work with synonyms and antonyms, the tasks for understanding new words and phrases from the text. Example of "Web-dialogue": *You have already wrote 5 questions for an interview with Jules Verne and you know what questions he will ask to you. Specify the expected answers to these questions. Give dialogue, write them down. Specify important to you personally part of this dialogue.*

2. The model group of questions "How?" or the stage of the bilingual person formation. Students compare their own educational product with the existing standard in this area and find links between the selected properties at this stage. The cultural-historical standard is based on the study of the Sciences, Arts, Traditions, Technologies, or it is reflected in different educational fields, as well as concepts, laws, principles that are considered fundamental achievements of mankind [12, p. 13]. The students master the Russian language in the framework of the saturation level of communicative and professional competence when working on the stage "How?". Student possesses linguistic, speech and communication material module of Russian as a foreign language and the module of professional language proficiency In accordance with the program of this level, that is indicative of a proper and skillful use of Russian, maximally close to the level of the average native speaker [13]. The formation of bilingual identity is inextricably linked with active students' academic activities with text. Students read the text, actively work on its analysis of various types of paraphrases,

put particular attention to creative retelling. It is advisable to use question-answering system, the role-reproduction of texts (especially dialogues) at this stage. The group tasks are aimed at the developing of skills in reproductive and reproductive-productive types of speech activity. All these activities involve students into active work with dictionaries. Execution is not only reproductive, but also productive work proves the formation of bilingual identity. This person has a perfect system not only of their native language, but also of foreign. So he can independently produce texts which he needs.

3. The model group of questions "Why?" or the stage of polycultural personality formation. This model, of the group of questions "Why?" means the transition to the creative level of processing of its own educational product after studying the benchmark in the educational field. The student receives a "general educational product" in the end. The student not only forms personal knowledge, which become deeper and wider, but also has more quality and experience and ability [12, p. 13.]. The transition to this stage means moving to the level of full and free competence of Russian language proficiency. This level involves students to "the free use of the Russian language as means of communication in all spheres of communication and in unlimited range of situations. Achieving this level indicates the assignment of the student the status of "power user language" [13]. Achieved the same level of polycultural personality means the assignments in order to develop productive skills of speech activity, contributing to the creation of both collective and private educational products. The work is used to be on-line (on the forum) at this stage. Examples of such tasks may be "Web-discussion" and "Web-essay". The "web" console indicates that the job of this type must be made on the forum. The students perform tasks in the classroom and as homework they place their "educational products" in the Internet and discuss them on-line with the other

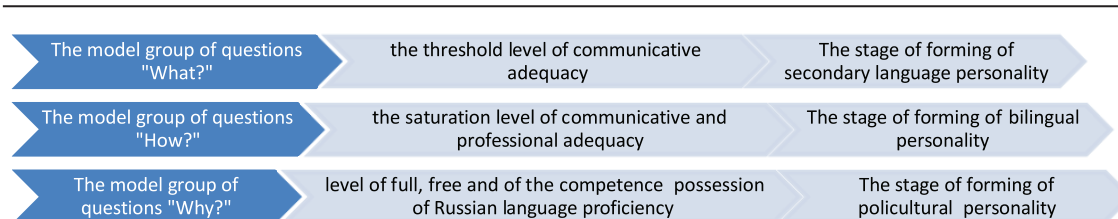
students at the beginning of the work. Example of "Web-essay": *Write a story by the given illustrations (Nesvizh castle). What a fantastic story could happen in this ancient and mysterious place? What are the characters involved in your story? There would be a fabulous characters such as fairies or perfectly ordinary people? Match your fairy tale with other student's fairy tales.*

Example of a "Web discussion": *I am a psychologist. The task of any psychologist is to help change the mood. How will you change the mood for: weeping willow, old rock, the old stream, a tiny speck of dust (write about it). Write on the forum their opinion about who and how they can help. Would you like to do? Compare your opinion with the opinion of other students. What is the difference and what are the similarities?*

In addition to these tasks the students can perform task "Web research": *At the present stage of development of the society the Internet is used by many people. Suppose the percentage of how many do people use the Internet in your country? In your city? In your Dorm? Draw diagrams. Conduct a mini-study among the students of your group on the topic "The Internet: How often? Why? Why do you use Internet?". The research will help you with the following algorithm:*

1. Give a name to your research.
2. Write questions for the questionnaire.
3. Fill out the survey form on platform Google, send to your friends the link to survey.
4. Draw diagrams according to the study.

Multicultural personality assumes full possession of listening skills. A distinctive feature of the work on the listening is the autonomy of its execution. The student can listen the text at any convenient time (the current level of the Internet development allows to do it) and all the tasks after listening are performed on-line. Example of task "Web listening": *View Youtube video "Calm as a boa. Techniques of stress management". Discuss in the forum these tips. Offer your own advice on dealing with stress.*



Stages of formation of the polycultural personality

*Formulate questions that you encounter while browsing to: a) an author of the video; b) to itself. Publish them on the forum and discuss.*

A correlation of the model groups of the heuristic dialogue, levels of learning Russian as a foreign language and stages of formation of the polycultural personality is presented in Figure.

### Conclusion

As practice shows the formation of multicultural linguistic personality is impossible without passing certain stages. This formation takes place always on the basis of the primary linguistic personality, because this is the person that speaks his native language and is formed from birth. Subsequently, on the basis of the primary linguistic personality can be formed the secondary language personality is a personality that studies a foreign language outside the language environment. This person is mastered in the structure of language and in its specific set of lexical, grammatical knowledge and skills. When the secondary language personality is adjudged to be in an alien language environment will be formed bilingual linguistic personality, i.e. personality, which is fluent in the native and foreign language. But fluency is not enough to move to level multicultural identity of one language. It is necessary that the personality was made not only by the language, as a structure, but also by the culture of other people. Learning through heuristic dialogue in the conditions of modern Belarusian higher education not only increases the efficiency of learning Russian language students, but also contributes to the development of another culture and to the forming of multicultural personality.

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## TRAINING OF SOCIAL WORK SPECIALISTS IN INSTITUTIONS OF HIGHER EDUCATION: PRACTICAL ASPECT

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The article describes the features of the practical training of future specialists of social sphere on the example of the Institute of social education, aimed at the development of personal, social and vocational traits, the acquisition of knowledge and skills, forming common cultural and professional competencies.

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**Keywords:** social sphere, personal, social and vocational traits, common cultural and professional competencies, Institute of Social Education

Practical training is one of the most important parts of professional training of any specialist. However, for future social work specialists, the stage of practical education is of crucial importance, as students learn how to work with various population categories, to solve social, psychological, economic problems, and to implement various social techniques.

We regard practical training of future social work specialists as continuous, sequential, independent, academic, research-related and extracurricular activity of students in fully functional environment of an institution of higher education, aimed at development of personal, socially and professionally important qualities, acquisition of knowledge and skills, building of cultural and professional competence.

Training of social work specialists started in the Institute of Social Education at the Ural State Pedagogical University in 1991. The Institute exploits a variety of supplementary opportunities for development of students' professional expertise, in particular, involvement of students in preparation for and holding of practical research conferences, academic and methodological seminars, round tables, etc. In order to improve efficiency of students' practical training, the Institute has developed an integral concept of, as well as learning and teaching resources for students' practical training in the context of multilevel education.

Practical training in the Institute of Social Education at the Ural State Pedagogical University is provided on the following aspects:

- theoretical (studying of subjects comprising basic and variable components of standard);
- practical (organization of practical trainings of various kinds);
- research (research supervised by tutors, participation in conferences, round tables – activities implying participation of

students in scientific events in the institution of higher education, writing of thesis statements and articles, carrying out of research as a part of term papers and graduation qualification papers, participation in project competitions, such as “Joint Activity,” “My Education Initiative”, “Professional Debut”, “Pedagogical Debut” etc.)

– cultural (extracurricular activities, organization of extended education, etc. – supervision of teams participating in events organized by the Institute and the student's academy of sciences, such as “Rough Diamonds of the Urals”; participation in volunteer movement, for example, Festival of Ten Thousand Good Deeds, etc.)

Within the framework of theoretical aspect, all units and models of professional training content are implemented, being a part of the Federal State Educational Standard of Higher Professional Education.

Practical aspect manifests itself in practical training of various kinds: introductory, academic, vocational, internship programs of the respective kinds of practical training differ from one another in the degree of complexity of objectives set for students. Thus, a first year student acts as a volunteer during his practical training, a second year student acts as a counselor, supervising an interim group of children during their summer holidays, a third year student is a specialist's assistant, a fourth year student is a specialist's alternate, and a fifth year student is an intern. Thus, every year a future social work specialist or social care teacher assumes more and more responsibilities, duties and functions.

Thus, during practical training, first year students *acquire* new knowledge, skills and competences, whereas second, third, fourth and fifth year students *not only acquire but also master* once gained knowledge and skills, acquired competences are verified in practical activity. Where, during their practical,

training first year students *participate* in work with a specialist, second, third, fourth and fifth year students *perform their independent professional activity* under supervision of tutors and specialists from the staff of institutions where practical training is done.

During their practical training, junior students *master* modern technologies, various forms and methods of social and socio-pedagogical work with various population categories, whereas third, fourth and fifth year students already independently find their way around social environment, knowledgeably perform social diagnostics and participate in development and implementation of various techniques, forms and methods of social and socio-pedagogical work.

It is also important that during practical training third, fourth and fifth year students develop creative and research approaches to professional work, carry out scientific research, which results are presented as term papers and final qualification papers. While they do practical training, it is important not only to develop professional expertise but also, as one of the principles of social work says, to “do no harm” to clients.

Practical training of fourth and fifth year students creates conditions for integrated application of knowledge, skills and competences, acquired by students in studying of Psychology, Pedagogy, Social Pedagogy, Theory and Techniques of Social Work, etc.

Practical training promotes self-determination of students, enables performance of experiment and exploration work in research topic in social institutions in their final year, prepares students for practical activity of social care teacher and social work specialist, facilitates adaptation of graduations of institutions of higher education at their work place, securing of position of young specialists, encourages professional self-improvement and self-development.

A number of problems are singled out in modern educational environment that are connected with organization of practical training:

- lack of a steady connection between institutions of higher education, social institutions and public authorities;
- lack of a clear funding system;
- practical training is not governed by the State Educational Standard, containing the following provisions: “...every institution of higher education should have its own system of practical training developed that includes its own program and principles for carrying out of practical training.”

All kinds of practical training are aimed at introduction of students to the most important kinds and means of practical psycho-pedagogical and socio-pedagogical work with children, adolescents and families, acquisition of new skills.

Practical training targets students at professional and personal development in order to solve their own inner problems and activate their personal resources, form their professional attitude and key competences.

The underlying aim of practical education is formation of specialist’s professional skills and personal qualities of moral and humanistic nature and mastering of all kinds of professional activity corresponding to qualification on the basis thereof.

There are a number of problems related to organization of students’ practical training that we are trying to mitigate. First, the duration of practical training (for social work specialists it is 24 weeks) is by far less than in western training models, where practical training of future social workers takes up to 50% of all time spent in institutions of higher education.

In the view of the foregoing, the Institute exploits a variety of supplementary opportunities to develop students’ professional competence, namely, involvement of students in preparation for and holding of practical research conferences, academic and methodological seminars, round tables, etc. In order to improve efficiency of students’ practical training, the Institute has developed an integral concept of, as well as learning and teaching resources for students’ practical training in the context of multilevel education. The topics of diploma work now include current projects that are socially important for the region. Monitoring of efficiently of senior students’ vocational practical training has been initiated in collaboration with representatives of practical training sites.

An innovative form of practical training was introduced by the Institute: the so-called voluntary practical training aimed at formation of voluntary and charitable work experience in future specialists.

The most important aspect of practical training is that during this period students may show themselves at their best, which often results in a job offer.

Such diversification enables research of the most topical issues related to social problems of our region: social security, health protection, socialization, social and socio-pedagogical rehabilitation, abilitation, adaptation of most vulnerable categories of citizens, prevention of social exclusion, and social integration, on the basis of dialogue of cultures.

Every kind of practical training sets and solves specific aims and objectives; year by year, practical training becomes more complex and embraces more functions, a set of roles of a future specialist becomes more sophisticated.

As a result of vocational training and internship, a student gets an idea of methodological and theoretical basis for work of social care teacher and social work specialist in real practical activity, familiarizes himself with regulatory and legal documentation of specific institution where he does his practical training.

Research aspect reveals the organizational basis of research work in professional training, in compliance with which it may be integrated in educational process, complement it or be concurrent with it.

Cultural aspect is represented by various kinds of organizational activity: culture and leisure, vocationally oriented, civil law, patriotic, informational and cognitive, as well as health saving.

Our more than 20 year experience of training of social work specialists proves that during students' practical professional

activity, interaction and spiritual communication develops between those involved in educational process, along with enrichment of system of values, reorganization of needs, interests, revision of aims of joint activity. Creative activity of practicing students and, consequently, the results of students' practical training essentially depend on the choice of priorities and formation of skills of students' independent work, on personalization of educational process, on reliance on personal and professional experience of every student.

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**MANAGING EDUCATIONAL PROCESS WITH A FAMILY.  
PRE-SCHOOL EDUCATIONAL ESTABLISHMENT:  
MANAGEMENT OF EDUCATIONAL PROCESS**

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In modern society, management of educational process with the family in pre-school educational institution is of particular relevance. The article describes the features of the interaction of specialists of educational institution with pre-school children and their parents.

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**Keywords:** educational process, family, pre-school educational institution, pre-school children, parents

Nowadays in conditions of humanization and democratization of education at different levels, particularly in pre-school education a task of improving the level of management of educational process in pre-school educational institutions task is becoming urgent.

Pre-school educational establishment presents such type of educational institution that implements the basic educational programme of pre-school education, and has particular goals, team structure, types and content of informative and communicative processes [2].

At the present moment educational establishment is a unique public institution that systematically and informally interacts with parents and students and has an opportunity to influence the family.

Management is considered to be a process of interaction of elements and subjects in the result of which we can get interrelated changes. Social order and specific needs of the family determine the functional range and purposes of a pre-school educational institution.

Management of educational process with the family in conditions of pre-school today requires new approaches and solutions that are able to take the peculiarities of educational and learning environment and requirements and needs of parents into consideration.

In pre-schools the nature of relationship between elements of the control system is carried out between the groups – “adults – adults”, “adults – children.”

The aim of managing pre-school is to ensure optimal functioning of these systems and high efficiency of upbringing and educational work with children at less time and effort expenditure. A head of pre-school educational establishment carries out full administration. He/she has overall responsibility for the work of entrusted institution [5].

Selection of the most important issues and depth of preparation for their discussion in the

Council of teachers and at the meetings of personnel, creation of business environment, co-ordination of staff work depend on a headmistress to a large extent. Co-ordinated activity at all levels of administration, and their relationship with the authorities of collective management ensures high effect in achieving goals [7].

It is necessary to mention that administrative actions of the head of a teaching staff in a pre-school should relate to constantly changing levels of pre-school education.

Educational process is professionally organized holistic educational process, characterized by a joint activity, cooperation, cultural content and methods of learning culture.

L.M. Luzina considers the process of upbringing to be a specially organized process in which social and educational purposes are realized, conditions for a full spiritual life of students are created to the maximum realization of their natural abilities, for updating their mental and spiritual potentialities [4].

A.S. Levshin regards an educational process as alive and complicated stream of different groups of pedagogical phenomena [3].

S.D. Polyakov determines the process of upbringing as a sequence of states, events, and changes, products of teachers' and children's interaction unfolding in time. He believes that in the educational process pedagogy is closely connected with psychology that it is sometimes difficult to say where one ends and another begins. The author examines the issue of education in its pedagogical and psychological aspects. This unconventional approach enables us to have a new look at the mechanisms, content, methods, specific features of different directions of the educational process [6].

The process of upbringing has a distinct structure of interrelated and regulated components:

- target component: the goals, objectives, and socialization of the child's personality;

- a substantial component – acceptability to the needs of an individual, educational standard;

- operationally-active: – organization of children's activities throughout the day;

- analytical and productive: the analysis of pedagogical activity.

Managing educational process with a family in a pre-school educational establishment should provide using human, technical, financial, time and other resources with maximal productivity for developing children of pre-school age.

Specialists of pre-school establishment have a leading role in managing and organizing educational process with parents and other members of a family. But this role is successfully realized in case of good knowledge of family peculiarities, pedagogical conditions of upbringing a child in a particular family.

Management of educational process with the family is a complicated process as it involves personal and professional commitment of all professionals of a pre-school educational establishment to gain and develop new approaches of working with parents, development prospects of education and instructional space, a choice of values for organizing educational environment. Besides it includes willingness of parents to interact with experts on a matter of pre-school children education.

The child cannot be limited only to the world of the family, otherwise later he/she will have difficulties of entering into a new social environment. That is why family and teachers of a kindergarten should combine their efforts in education taking into account advantages and disadvantages of everyone and a possibility of mutual compensation.

Family and teachers of pre-school educational establishment create microclimate where a pre-school child lives. It is the environment from which a child gets necessary TV information and adapts to life in society.

Contemporary parents are educated, have a wide access to scientific and popular information from the sphere of Education and Psychology. However, a high level of general culture, erudition and knowledge of parents do not guarantee a sufficient level of their pedagogical competence. Parents have difficulties in developing, educating and training their children, in choosing effective methods and techniques in applying information gained from the Internet and popular science in practice. Experts note constant need of parents to get specific targeted assistance for educating and training children.

Those experts of preschool education are able to render assistance to these parents.

In order to form a position of cooperation of teachers, children and their parents it is necessary to create a unique space of child's development which should be supported by pre-school and a family.

In order to organize effective communication of teachers and parents it is important to possess communicative skills and be aware of educational problems of every family. Communication will be successful if it is informative and based on common and significant themes, and while communicating every side enriches their knowledge and skills.

Forms and methods of work with parents in a pre-school establishment are determined by the following factors: the level of general and pedagogical culture of parents; types of family relationships, specific features of a pre-school establishment, age peculiarities of children, etc. There are the following ways of working with parents of preschool children:

- mass forms: lectures, discussions, question and answer sessions, parents' meetings, etc.

- group forms: working with a parents' committee, counseling boys' to girls' parents, etc.;

- individual forms – counselling about age peculiarities, visiting family, etc.

Cooperation of preschool and a family suggests that parents should have a responsibility and teachers have centrality of family educational activities based on consideration of a child only in the context of the family. The main way to establish such cooperation is organizing educational process, which will result in realization of purposes and principles of personality-oriented education of preschool children [1].

According to educational potential families can be divided into three groups:

1. Families with high potential are mainly active parents' group. The main challenge in working with this group of parents is to involve them into educational work of the group, into organizing assistance to families with middle and low capacity to use progressive teaching practice of bringing children up gained in these families. As a rule families where children are respected have the most favourable educational conditions.

2. Working with parents with middle educational potential we should focus on developing skills of proper organization of family entertaining activities, of family daily living in order to avoid possible mistakes in the process of educating children and to establish unified demands for children at home and in a pre-school establishment.

3. The main challenge in working with parents with a low potential of the family is to come into contact of a family and a pre-school establishment, to create ideas about parental duties, to raise educational culture, to help parents to adjust conflicts and to improve parent-child relationships.

Необходимо отметить, что в условиях дошкольного образовательного учреждения процесс воспитания направлен на:

It is necessary to mention that in conditions of pre-school educational establishment an educational process is directed to

- holistic education of an individual with the goal of comprehensive integrative development of a personality;

- moulding moral qualities of a person on the basis of human values, socially oriented motivation, harmony of intellectual and emotional spheres of personal development and volition;

- acquainting children with social values in the field of culture and art;

- developing inclinations, abilities and interests of a personality taking his/her possibilities and desires and social requirements into consideration;

- organizing cognitive activity of children;

- organizing personal and socially valuable, versatile activity influenced by the aim of developing personal qualities.

It is necessary to pay special attention to monitoring as a managing function. Monitoring function is an integral part of management. Monitoring function enhances responsibility of specialists.

Monitoring in pre-school establishment is a system of examination and control in accordance of educational process with goals and tasks of educational programme and the Charter of municipal budget pre-school establishment.

Through monitoring management gains the most essential component, without which it cannot exist. It is feedback. Monitoring makes management "able to see" i.e.

responsive to changes. It can be carried out as re-questioning of teachers and parents to identify positive dynamics.

Monitoring should be regular, systematic, efficient and transparent. A head of pre-school establishment and a senior teacher should create such conditions in which control is as effective as possible other teachers are interested in its objectivity.

Thus, management of educational process with a family in a pre-school educational establishment involves personal and professional readiness of all experts of pre-school educational establishment to adopt and develop new ways of working with parents.

The main aim of management of educational process with a family is to establish of trustful relationship between children, parents and educators, uniting them into a single team. Managing educational process enables experts of pre-school educational establishment to refuse from evaluating strategy in relations with parents. Indeed, experts should create a friendly atmosphere of a dialogue, be attentive to the problems of parents and their worries, to teach parents to examine behaviour of their child, to pay attention to his/her peculiarities and abilities, to be able to infuse parents with hope for success in the educational process of their child.

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## THEORETICAL BASIS FOR ADAPTIVE EDUCATION IN THE ZONE OF NEAREST DEVELOPMENT

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The authors offer providing individually adapted technology to be used under conditions of frontal teaching and realizing mental paradigm of education – technology of adaptive teaching in the zone of nearest development. At that, not only experimental but also theoretical foundations of its validity and reliability are given.

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**Keywords:** adaptive teaching, zone of the nearest development, dominant, topological, projective, orderly, numerical, and compositional thinking clusters

When analyzing the state order to school in Russia, including higher school, we can admit that within several recent decades it has been constantly changing. During the times of Khrushchev's "thaw" trying "to catch up with and to overcome America" our country put emphasis to science-technical revolution, and "the epoch of STR" demanded from school graduates possessing most up-to-date knowledge and methods of learning. So modernized didactics was needed and our science of education created it and found out corresponding methods of teaching. Thus problem-oriented teaching (A.M. Matyushkin, M.I. Makhmutov), TRIZ – Russian acronym for «Theory of Solving Inventive Problem» – technology by G.S. Altshuller appeared.

But as far as there turned out to be no advanced technologies in the country which were to be taught to the students it was decided to orient education to the formation of from all sides developed person. This state order was met by our science of education with a number of educational technologies, the concept of developing personality (N.A. Menchinskaya) in particular, etc. But

having realized the unreality of the task (is it possible to form everything?) the state order was formulated in a more detailed way. Now it was required to form a harmonically developed person. The difference was that a harmonically developed person had to possess not all positive qualities and phenomena but only those needed by the society at a definite moment. As a result, there appeared optimal education (Y.K. Babanskiy) and personality -oriented education (I.S. Yakimanskaya).

The period of "perestroika" and the transition to market economy washed away and shifted the stresses in the requirements to graduates of educational institutions on the one hand, and demanded from them very quick and precise orientation in a rapidly changing society, on the other hand. "Who possesses information,

possesses the world". And so, the science of education started supporting this position. The society was not called "industrial" any more. And a new type of person alongside with the new unity "soviet nation" was not formed any more. We started to call the society "informational" where computer got a dominating position. Primary school children began to study Informatics and so new methods of teaching (informational) were introduced.

But with all its immense capacities computer is still unable to think. Thinking is so far the ability only of a human being. That is why now we are observing the transition from informational paradigm to mental, sense containing.

The going off of the totalitarian society gave birth to the diversification of education directed to individual development of a person. The state sets only some standard, some general level (for example, GSE – General State Exam), but educational technologies, to provide for the result, are not given "from above". This situation leads to an abundance of various textbooks, methods, programs which are supposed to develop personality of a student. Some of them are not only declarative but sometimes even didactogenic unfortunately. A flow of theories of education (not always high quality) poured into the emerged lacuna. We saw the aim of our investigation in the creation of versified individually adapted technology to be used under conditions of frontal teaching and realizing mental paradigm.

The theory of education worked out by us is based on several psychological laws.

The first of them is systemic character of psyche. It was very well-grounded in the science of education already in classical works by K.D. Ushinsky, L.S. Vygotsky, etc. One of productive steps in this direction was made by N.I. Chuprikova, who formulated the universal fundamental law of mental development – the law of systemic differentiation. Basing on this law in our earlier research works we set

the goal to describe concrete psychological mechanisms and mental development genesis by means of differentiation of the mind structure in students. In those works the hypothesis according to which mental development is going on due to differentiation of main mind substructures was tried and confirmed. And it is a really “childish way” of acquiring not only direct but also indirect forms of the consciousness.

But the substructures differentiation provides only for the initial level of mental development, though sufficient for non-professional activities. Later, higher levels are achieved by constant cyclic changing of differentiation and integration of psychic processes (at the beginning) in the substructures. And then mental development within these substructures takes place on the “upper floors” of its formation.

What is the psychological mechanism of this progress? In the search for the answer to the question it was established in our earlier works that the structure of the mind is the intersection of five main substructures. Their development takes place in the following sequence.

The first are topological representations. They appear in children at the age of three. As our research showed, the first most general non-differentiated mind substructure is formed on this base. We have named it a “topological cluster”. Thanks to it a man starts distinguishing between such characteristics as continuity, coherency, compactness, closeness in objects and relations.

But these rather general characteristics don't let us differentiate homeomorphic objects. Within the framework of topology it is impossible to distinguish between, for example, looking quite differently, a circle and a square, as these figures are both continuous, coherent, compact, and closed. But the social situation of development requires their differentiation from a child. That's why he “learns” to find out and to operate the tolerance phenomena (relations of similarity). Thus the next mental substructure – “projective” is formed in a person. Its invariants are: establishing of similarity between similar objects and their depictions performed in different projections and from different angles, objects and ways (possibilities) to use them differently in different situations.

But it is not enough. As it turns out similar objects can differ noticeably as well. They can differ by their size (bigger, longer), by position (below, in front of, parallel, perpendicular), by form (circular, rectangular, triangular), by temporal characteristics (in the beginning, before, after), etc. So the next “orderly” “cluster devel-

ops as a result of “acquisition” of quasi-, linear and partial putting in good order lots of objects and relations by a person.

But the differentiation goes on. The above mentioned relations and phenomena get better expressed and more precise qualitative characteristics: not simply bigger, but 7sm against 5sm. The result of it is the development of the next “metrical” cluster in the mind, which provides for finding out and operating numerical characteristics of objects.

Then the processes of integration are switched on in the mental development genesis and the law of systemic integration is realized. This “is reflected, firstly in the growth of interrelations between elements and subsystems, and, secondly in that subsystems and elements performing similar functions integrate into more generalized subsystems and elements forming higher levels in the structure of the system” [9; 9]. The result of this mental activity is the development of “compositional (algebraic)” cluster in the mind structure. Thanks to it a person follows and operates composition laws, discovers reversibility of numeral actions and transformations, “contracts” them, performs them in any sequence, substitutes several operations by one, divides and unites (combines) relations and elements, etc. The presence of this cluster in the human mind structure is evidence of its rather high intellectual development level<sup>1</sup> [2, 69–95; 3; 5].

The described clusters are not isolated. They intersect with each other in all mental operations. And always among them there is a major, dominant one. It defines the character and the content of mental actions in the process of decision of this or that task, individual preferences in distinguishing these or those object characteristics and ways of thinking. This substructure turned out to possess a generalization quality: it is actualized and it functions in different situations with different contents. The relation of the dominant substructure with various ways of its use is established in a student's mind. According to our research all students differentiate quite steadily in five groups according to the dominating substructure (cluster) in their mind.

We have discovered that to decide the task, from psychological point of view, first of all,

<sup>1</sup> It should be noted that many of psychologists considered such a phenomenon of the compositional cluster as, for example, reversibility of mental operations to be the “core of cognition” (J. Peaget), intellect (N.A. Menchinskaya), high level of mathematical (V.A. Krutetskiy), geographical (E.N. Kabanova-Meller), physical (Z.I. Kalmikova) type of thinking development, “the field of essence” (V.V. Davidov).



means to “reformulate”, to “translate” it into the “language”, into the terms of your dominant cluster [4; 6]. The point is that, as soon a person manages to “introduce” a task into the framework of his dominant cluster, «lets it in» it, the structural mechanism of thinking, described by S.L. Rubinshtein switches on. The mind begins, in accordance with isomorphic to the cluster relations laws, actively transform, “reformulate” the task, “excavating” from the object more and more new content; as if it is turning to another side each time, and thus, demonstrating its new characteristics [8, 99].

In other words, it can be assumed that the real comprehension of the task content, and its decision is achieved by the student, only if he succeeds to consequently “put it right” and to expound it within the frames of his dominant cluster [4]. So it is not hard to assume that the effectiveness of teaching is achieved if the teacher expounds the material in the “language” adequate to the cluster of each of his students. But here is a quite natural question about possibility of building up and realization of such tuition in a group (class-lesson system). On the one hand it is just impossible to give the same material five times running within the frames of different clusters, or in five “languages” simultaneously. On the other hand the teacher himself would involuntary tend to decide the task and to expound the material in the way isomorphic to his own dominant cluster, which is different to the cluster of the majority of his students. The situation seems to be hopeless. According to the hypothesis of this research work our specially developed technology gives the solution. This technology performing integrative function in teaching is “the technology of adaptive teaching in the zone of the nearest development”.

It is based on the following principles.

1. Teaching is built up on the organization of the research activity of students.
2. The teacher occupies the position of a “social organizer” of their cognitive activity.
3. When organizing the students’ cognitive activity the teacher doesn’t speak in a narrative way except for when introducing new terms. All the teacher’s addresses to his students are formulated only in the interrogative form.
4. The questions to the students are not planned in advance.
5. They are not formulated intuitively or voluntary, but according to the strict algorithm.
6. The algorithm is as follows. In the last narrative sentence of the student (his answer to the question) the teacher chooses a key word – the word bearing the major sense loading and

formulates a question to this word. For example, the student answers: “I think it is necessary to go”. The key word here is “to go”. It is the word to which the question is formulated: “Why go?”<sup>2</sup> The student gives his answer. The teacher again asks a question to the key word from the student’s new answer, and so on, until the student himself comes to the solution.

It is clear that the student formulates his answer, its meaning within the frames of his dominant cluster. Asking the question to the main meaningful (key) student’s notion, the teacher minimizes the possibility of his question formulation to escape the frames of his student dominant and involuntary finds himself within his student cluster. So the question becomes understandable not only for the student who answered but for all other students with the same dominant cluster. During the dialogue (frontal or individual) a natural consequent chain of conclusions is being built and it leads to the teacher-planned result.

Those with other dominants are trying to paraphrase the dialogue and to insert it in the frames of their substructures. If they can’t do it on the spot, they apply to the teacher or to the classmates. As a rule, one or two replies from the teacher or from the classmates with the same dominant are enough to remove the difficulty and to advance him to the next logical stage. During the heuristic dialogue it’s rather easy to discover everybody’s place of intellectual difficulty. And everyone “gets out” of it very quickly again with the teacher’s question addressed to the key word, or with the comments of the classmates with the same dominant. Thus the question about methods of frontal work with the students having different clusters is removed.

But there is another problem. If the teacher creates for the students conditions which are adaptive from the point of view of mental development and works with everyone in his dominant cluster can there be some slant? Will everyone develop only one dominant cluster, but not the others? This question can also be answered negatively. And for such an assertion there are other theoretical foundations besides our verification. The thesis about continual-genetic (non-disjunctive) nature of the psyche can be referred to such foundations [8; 1]. According to this thesis, «thinking as a real, live process is not disjunctive ... Different stages ... are interconnected so tightly, so intrinsically, that ... continually seem to penetrate each other, fuse, genetically transform one into another, etc.» [1, 13] It means that

<sup>2</sup> You can learn about this technology in more details, for example, in our works [3; 7].

when one cluster is developing other (all the rest) clusters are developing too, so general mental development is going on<sup>3</sup>.

Since the student in such tuition is constantly leaning on and operates non-dominant clusters (thus developing them) he is forced to

Number	Criterion	Traditional tuition	Adaptive technology of mental development
1	Teacher's function	"a guide", "a rickshaw", To be ahead of students <sup>4</sup>	A "social organizer" <sup>4</sup> , To be behind, to follow students
2	Teacher's position	Formational (egocentric): the teacher "reads in", "writes in" his student into himself	Personality-oriented (off-centric): the teacher «reads out» of his student and takes him into himself
3	Character of teacher-student interrelations	the teacher goes to the students with his subject, his academic discipline	the teacher goes to the subject, academic discipline together with his students
4	Educational trajectory	Is set by the teacher	Is chosen by the student
5	The main principle of students' mental development	Purposeful impact on the students' intellect to form mental abilities corresponding to the norm and set in advance	Creation of conditions (social situation of development) for students' intellectual self-development
6	Orientation	To successfulness of the activities (increase in volume and speed of information processing, ability to decide many complicated tasks)	To realization of individual mental resources (competence, initiative, creativity, mental self-regulation, independent choice of learning methods, ability to work with discrepant, paradoxical information, dialogical thinking)
7	Support	Individual psychological peculiarities of each student	Common laws and mental development genesis at a given age period
8	Formation of action and knowledge operating method	Offered by the teacher, or discovered under his leadership the one and the only true method «scientifically grounded», which can be really their own for only some students	A student under the leadership of the teacher builds his own method, which he believes in and is sure in its scientific foundation
9	Cognitive activity	Prevalence of verbal knowledge and thinking ways as a result of verbal-logical method of tuition and a place in the world given by the adults	Prevalence of non-verbal knowledge and thinking ways as a result of their own acquisition and their own defining of their place in the world
10	Thinking – memory ratio	Students remember, understand the instruction and try to act in accordance with it. The leading process is memory	Students discover and create their own action algorithm, method of acting. The leading process is thinking
11	The world picture	Adequate to the offered (by teacher or book) or to reality reflected in a student by scientific knowledge acquisition	Non-adequate, abundant, including what doesn't exist yet, and what possibly will never be. The result of student's own construction and generation
12	Existence methods	Adaptation to the surrounding world	Constant search approbation and testing of the self in the world

<sup>3</sup> Generally speaking this is characteristic of all living beings. It can easily be observed on the example of sportsmen. Thus in those doing lawn tennis and operating mostly only one arm the other arm is also developing. The man doesn't become asymmetric.

<sup>4</sup> According to L.S. Vygotskiy's terminology.

be in his individual zone of the nearest development (L.S. Vygotsky).

Lasting for many years, experimental approbation of the described technology in Novgorod, Ivanovo, and Nizhniy Novgorod regions proved to be highly effective. In comparison with traditional tuition our approach called “adaptive technology of mental development” has a number of advantages, which we present in the conclusion.

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## “GLOBAL SECURITY: A LOOK INTO THE FUTURE”: CONCEPT AND IMPLEMENTATION STRATEGY OF PROJECT

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The article explains the relevance of global security in today's educational environment. The major issues of our time in a globalized world are identified. The authors propose an international scientific and educational project, which is based on the cultural approach, involving the study of national systems and increasing the potential for analysis of the various spheres of human life and society in the dialogue between them to study and develop a strategy for global security.

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**Keywords:** global security, cultural approach, an international scientific and educational project, social and psychological security, communicative security, information security, ethnic and cultural safety, social responsibility, consumer safety, the prevention of social pathologies of the individual and society

Global security as an idea and theory of contemporary cultural borrowing in the diffusion process of European innovation becomes extremely popular in the international scientific space, since it not only emphasizes the importance of social integration in a globalizing world but also presents real steps towards ensuring the utmost security both for an individual and society.

At the forum “Russia 2012” V.V. Putin said that the coming decade is the time of challenges, risks and transformations. Transformations of Russia at the end of XX – the first decade of the XXI century increased the need for modernization processes in this country, too. To date, the problems that exist in one state, there are, as a rule, the problems of the world community. Since each state is a small unit of a large global community.

The most important problems of our time in a globalized world are:

- solution of raw materials and energy crisis;
- end of the arms race;
- eradication of epidemic diseases, strengthening the fight against cardiovascular diseases and allergic diseases, AIDS, diseases of the nervous system; the elimination of socially conditioned diseases, etc.;
- control of the demographic processes (births, infant mortality, migration);
- informatization of society;
- reducing ethnic conflicts;
- preservation and development of the spiritual culture of the peoples, eradication of terrorism and crime;
- preservation of the national identity and civic identity;
- maintenance of national, social, communication, information security;
- creation of guarantees for safe childhood.

Along with these challenges and risks in the XXI century, new threats and challenges appear; they are global in nature, such as international terrorism, juvenile delinquency, child abuse, adoption of children by foreign citizens, registration of same-sex marriages, development of open educational environment, consumer safety, etc. So, today our attention is focused on global social problems that relate to both an individual and society as a whole.

The existence and progress of human civilization depends on the solution of global problems. But their solution is possible only with rational combination of national efforts and the activities of an effective system of international cooperation.

Thus, the solution of global problems requires the combined efforts of all mankind. Dissociation of force, confrontation can lead to irreversible consequences, including international conflicts. Therefore, humanity is “doomed” to interaction and cooperation, to the expansion of scientific, cultural and educational ties. The motto of our project is “Mankind in a single dialogue”.

In addition to characteristic of the modern theory of global security integrative and interdisciplinary approaches, the proposed project is based on a cultural approach, which involves the study of national systems and extends the analysis of the various spheres of human life and society in the dialogue between them to study and develop a strategy for global security.

International scientific-educational project “Global security: a look into the future”, initiated by the Institute of social education, Ural state pedagogical university (ISObr USPU) has a number of prerequisites. First, one of the main prerequisites for the development and testing of this project was the desire of Russia to take the initiative entitled “Global mind. The

future of globalization and its impact on our world” by taking part in the exhibition World Expo 2020.

Second, the problem of global security is dictated by the global trends that are declared in the international and Russian legal documents and reflect the opinion of mankind in the future:

- Declaration of Human Rights.
- The UN Convention “On the Rights of the Child”.
- The Constitution of the Russian Federation.
- Federal Law of the Russian Federation from 28.12.2010 № 380 “On Security”.
- The State Program of the Russian Federation “Information Society (2011–2020)” (sub-program “Security in the Information Society”).
- Doctrine of Information Security of the Russian Federation, approved by the President of the Russian Federation 09.09.2000 № Pr-1895.
- National Security Strategy of Russia until 2020 (approved by the President of the Russian Federation from 12 May 2009 № 537).
- The concept of long-term socio-economic development of the Russian Federation for the period up to 2020, etc.

Third, ISObr USPU initiated this project, with the following bases:

- in 2007–2008 the Institute took part in an international TEMPUS-project (Germany);
- in 2009–2010 there was realized a scientific research “Modern information and psychological wars in Russia’s political space: communication, geopolitical and ethno-cultural trends”;
- in 2009 there was introduced training of students – future bachelors of “International Relations”;
- there were introduced training courses “Prevention of dependencies”, “Principles of self-knowledge and self-realization”;
- in 2010 there was introduced training courses “Russia’s national security”, “Information wars”, “Basics of cross-cultural communication”;
- in 2011 there was introduced a course “Social and legal protection of motherhood and childhood”, in 2012 – “The development of the child in substitute family”;
- the following monographs were published “Space and communication: the relationship and interdependence” (2010); “The culture of non-verbal communication” (2011); “Transnational discourse: a model in the context of the times” (May 2013), and others;
- in September 2013 there were opened the following Master programs “Management of advertising and PR: communicative security”, “Communication management and international security”.

For the formation of new social and cultural patterns of the world there is the need to attract young scientists, students of all countries to find solutions to the security of human existence, adequate, not only its present but also the future. Therefore, the main participants in this project are the students, university professors, research associates. Representatives of government agencies, municipal departments; representatives of non-profit organizations, associations; employees of consulates and government representatives are also involved with the project.

The purpose of the project: the development of scientific and practical substantiation of measures to ensure global security of an individual and society from external and internal threats in interpersonal, intercultural, educational, social and business communication at different levels of education and life cycles through international collaboration and cooperation.

Objectives of the project:

- scientific foundation for global security in the process of interpersonal, cross-cultural, educational, social and business communication;
- development and theoretical description of the techniques and technologies to ensure security of an individual and society in the process of interpersonal, cross-cultural, educational, social and business communication at different levels of education and life cycles;
- promotion of techniques and technologies to ensure global security through scientific, practical and educational activities of various forms (on-line events, conferences, workshops, seminars, lectures), interaction with the media;
- test the methods and technologies for the global security of an individual and society;
- design of the project.

Project implementation period: 3 years (September 2013 – June 2016)

International partner universities:

1. Jilin Institute of foreign languages (China).
2. Kostanay engineering and economic university (Kazakhstan, Kostanay).
3. National technical university of Ukraine (Kiev, Ukraine).
4. Grodno state university named after Yanka Kupala (Belarus, Grodno).
5. Kaunas university of technology (Lithuania, Kaunas city), etc.

Implementation of the project involves the implementation of three phases:

- organization and preparatory phase (problem setting, the rationale relevance of the project, the formulation of goals and objectives, the conclusion of agreements with partners (September-October 2013);

– main phase: problem solving of the project is in the process of implementation of the program of scientific, practical and educational activities of the various forms of the three modules: “Global security”, “Social security”, “Safe childhood”;

– analytical phase: a synthesis of the project and determination of the prospects for further development of the project.

In the framework of scientific, practical and educational activities of the project the following global social problems are determined, disclosed and resolved :

- social and psychological security;
- communicative security;
- information security;
- ethnic and cultural security;
- social responsibility;
- consumer security;
- prevention of social pathologies of the individual and society.

**Module I “Global Security”** includes the following activities:

The problem of social and psychological security:

– workshop “Social and psychological security of an individual and society: national and international aspects”;

– discussion platform “Safe environment for the implementation of the rights and freedoms of man and citizen as a focal area of national security”;

– conference “International security: international and interstate relations in the modern information society” (working language – English);

– competition of students’ projects, “Securing Russia’s national interests in the global information society”;

– project competition “Providing information and psychological security of an individual and society”;

The problem of communicative security:

– scientific-practical conference “Modern Communication: experience, problems and prospects” (working language – English) (April 2014);

– conference “Communicative security in the public and business management”;

– seminars “Communication management: modern techniques and technology”;

– workshop “Self-management as a basis for professional security”.

The problem of information security:

– teleconference “The development of the information space of the state”;

– master class “Modern information and communication technologies”;

– project competition “Common cause”, dealing with the mechanisms of information security to improve the quality of life.

The problem of ethnic and cultural security:

– conference “Modern information-psychological wars: communication and ethno-cultural trends”;

– discussion platform “Acculturation as a form of intercultural communication: risks and consequences”.

The problem of consumer security:

– course of lectures “Consumer Safety”: themes “Russian laws on consumer protection”, “Consumers’ right to an adequate quality of goods, works and services”, “The right of consumers on product safety”, “Consumer protection in the sale of goods”, “Protection of Consumer Rights in the performance of works and rendering of services”, etc.

The problem of social responsibility:

– conference “Development of corporate social responsibility in business: domestic and international experience”.

**Module II “Social Security”** includes the following activities:

The problem of social security:

– conference “Creating a barrier-free environment for people with limited mobility: national and international aspects”;

– seminars “Inclusive Education: the domestic and international experience”.

The problem of ethnic and cultural security:

– conference “Acculturation of migrants: communication and ethnic aspects”;

– round table “Migrant phobia as a factor in migration processes and the problem of ethno-cultural security”.

The problem of communicative security:

– master classes “Prevention of conflicts in professional communication of specialists of the social sphere”, scientific and practical seminar “Burnout syndrome of specialists of the social sphere: the communicative aspect”.

The problem of consumer security:

– colloquium “Consumer safety of the elderly: theory and technology”.

The problem of social responsibility:

– conference “Social technologies to improve the quality of life of the population”;

– forum “The role of cultural and educational space in shaping the social responsibility of young people”.

Prevention of social pathologies:

– seminar “The problem of social fallouts”;

– conference “The conceptual framework for prevention of social pathologies of the XXI century: problems, solutions and prospects”.

**Module III “Safe Childhood”** includes the following activities:

The problem of ethnic and cultural security:

- seminar “Prevention of ethnic conflicts among adolescents”;
- conference “The adoption of children by foreign citizens: experience and problems”;
- discussion platform “Preventive approach to the protection of children from violence and abuse”.

The problem of communicative security:

- conference “Safety of real and virtual communication in child and adolescent environment”.

The problem of consumer security:

- conference “Development of consumer culture in children: threats and protection mechanisms”.

The problem of social responsibility:

- conference “Social responsibility: individual, society and state”.

Prevention of social pathologies:

- conference “Prevention of social pathologies in children and young people”;
- seminar “Social norm: who is to blame and what to do”.

At the end of each year of the project scientific conferences are planned to take stock of the intermediate and final results of the project.

Results of the project:

- implementation of cross-cultural research (projects, term papers and final qualifying works, thesis, including Masters’ thesis) of the socio-psychological security; communicative security; information security; ethnic and cultural security; social responsibility; consumer security; the prevention of social pathologies of an individual and society. For example, “Research of the problems of providing information and psychological security of an individual and society”, “Study of the socio-psychological effects of widespread use of modern information technology”, etc.;

- functioning of the scientific school “Transnational discourse in the context of global integration and confrontational processes”;

- training of foreign graduate students;
- development and testing of information and communication, socio-psychological projective techniques and technologies;
- the creation of experimental platforms on the basis of educational and social institutions;
- writing and publication of monographs (individual and collective);
- development and implementation of training courses “Information Law”, “Communicative security”, “Consumer security”, “Ethnopedagogy”, “Prevention of social pathologies”, etc.;
- development and publishing of training manuals;

- organization of students’ and teachers’ abroad probations, including implementation of academic exchange of students;

- development and testing of advanced training courses “PR and advertising communications in the social sphere”, “PR and advertising communications in the commercial sphere”, “Technologies and techniques of inclusive education”, “Preparing tutors of the education system”;

- functioning and development of the Student Academy of mass communications;

- development of the concept and testing of the School of tutors, School of volunteers;

- establishment of the Centre of universal education at the Institute of social education, USPU.

Thus, implementing the project in collaboration with international partners, we will be able to join forces to develop essence, criteria, conditions and implementation of specific mechanisms and ways of ensuring global security (social-psychological, communicative, social, etc.) of an individual and society in the process of interpersonal, cross-cultural, educational and business communications.

Project data are located on the platform **isobr.uspu.ru**

## PODCASTING AS A TECHNICAL WAY OF INTERACTIVE COMMUNICATION OF XXI CENTURY

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The article analyses podcasts, a type of multimedia used for creative tasks, which motivates students and improves their mass media literacy relevant for the use of a foreign language in real-life situations. The article also addresses the didactic potential and the limits of the use of Internet in foreign language training and describes the incredible potential of podcasting for those who wish to listen to a speech in a foreign language and to improve their language skills. Under the current state educational policy the main aim is to ensure the quality of training and the introduction of modern computer technology in education [1].

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**Keywords:** podcasting, computer technology, the quality of teaching, audio texts, audio blog, media literacy, Internet, information and communication technology

Along with education, training and personal development of the students, one of the objectives of foreign language teaching is the formation of communicative competence in a foreign language. Public education of the third generation places high demand on teaching of foreign languages. Such requirements are dictated by necessity: with globalization, global integration and harmonization in the field of economics, politics and culture, large numbers of people from different countries and different continents roam the world in search of jobs, better living conditions, striving to fulfil their intellectual and creative abilities, to meet their ambitions, to achieve professional success and career development, to obtain quality education and training. Consequently, they must be skilled in communicating in a foreign language, from the simplest, basic conversational clichés used in everyday situations, to knowledge of oral and written form of a particular foreign language. This vital need is the best motivation for learning foreign languages. And it does not concern only English, the traditional language of international communication, but also other European languages such as French, German, Spanish, Italian, etc., i.e. languages also necessary for establishing successful business contacts with European partner companies, and for training and working in the EU. Nowadays, knowledge of at least two foreign languages is essential.

With the development of the Internet, its active users have been provided with participatory applications such as blogs or podcasts, and new perspectives for the study of a foreign language have opened up, perspectives associated with people's desire to create and share products in foreign language on the Internet. Success in learning through communication on the Internet has been proved by many studies

and surveys which have confirmed not only improvement of language skills or development of intercultural competence among students, but also an increase in their motivation once the results of their work is published on the Internet for a wide range of users.

Currently, priority in language teaching is given to authentic communication, to language within a cultural context, to independence, and interactive learning. As has been established, the use of the Internet in foreign language teaching enhances speaking, vocabulary learning and grammar. However, even more significant is the use of information and communication technologies in the process of learning a foreign language as the main mode of development of students' independent cognitive activity. These new forms and methods of teaching as well as new approaches to learning are associated primarily with the mental operations of analysis, synthesis and abstraction, identify and compare, comparison, verbal and semantic prediction [2, 284].

### Analysis of the latest research and publications

Podcasting, along with other media resources, nowadays represent the essential technical means of learning a foreign language and provide solution to complex problems of foreign language education. Skills generated by listening to podcasts go far beyond mere improving of one's linguistic abilities.

Research questions related to podcasting as a means of interactive communication and identification of related features were among others addressed by M.T. Baimakhanov, T.M. Abdrakhmanov, V.N. Uvarov, A.I. Khud'yakov and A.A. Chernyakov.

The researchers note several advantages of using this technology: the full development of students, the use in teaching different subjects,



including remote maintenance of interdisciplinary communication, and accessibility of education.

This field has also been explored by several Russian scientists, including S.A. Trofimenko, E.E. Tkachenko, B.S. Salin, E.P. Kovalskoy, E.S. Polat, A.P. Avramenko and A. Zelenovsk.

However, in view of the many requirements and challenges of modern methods of teaching a foreign language, our subject of investigation is far from being fully examined. Many theoretical and methodological issues related to podcasting as a means of interactive communication have either not been addressed yet or well understood, and require further scientific scrutiny.

The purpose of the study is to find a way to integrate podcasting in the process of learning a foreign language, to explore the didactical potential of the Internet.

At first glance it may seem that podcasts are applied to a sufficient extent in the education sector. In fact, this is not the case, although with the imagination and creativity of teachers and students, podcasts can give new life to learning. This technology allows you to present new materials and vocabulary to expand the semantic field and train language material, and enhance the social competence of students.

#### **The main results of the study**

One of the new means for teaching foreign languages is to create interaction in class, i.e. to apply the method of interactivity. Interactivity is a “union, coordination and complementarity of efforts communicative purpose and effect speech means” [3, 284]. O.N.Shulga defines the interactive approach in the virtual space as one of the means to achieve the purpose of communication in class, differing thus from the principle of communicative presence of true cooperation, where the emphasis is on developing communication and collaboration skills. In a broad sense, the term “interactivity” suggests one of the main principles of learning. Among the major features and interactive tools used are polylogues, dialogues, mental activities, intersubjective relations, freedom of choice, their application in teaching is successful, positive and optimistic [3, 285–286]. By implementing the interactive approaches in modern educational process researchers promise to increase the effectiveness of teaching to communicate in a foreign language [4, 260].

Being interactive, the Internet enables us to achieve self-development through observing and copying other people’s use of the language. The tools of interactive communication provided by the Internet are synchronous communication (real-time communication)

and asynchronous communication (communication with a time delay) [5, 50], such as audio-blogs and podcasts, voice mail and voice forums, digital recording broadcasts or similar programs which are available on the Internet for downloading to a personal audio player [6, 482]. Therefore, podcasting does not only innovate but also modernize the current use of recordings and audio and video clips in teaching. Thanks to online distribution, digital format opens limitless possibilities. For example, users can subscribe to podcasts and receive updates of specific resources. It is the very possibility of subscription that makes podcasts new phenomenon not only in the world of technology, but also in the field of didactics.

From the methodological point of view, podcasts promote the formation of oral language skills. This technology allows teachers to present new materials and vocabulary in order to expand their semantic fields, to practice the language, and to create social competence of students. Podcasts can be applied as material for receptive tasks and also for the development of speaking, training and monitoring of prepared and unprepared speech. Podcasts might also be used for project work. All of the above skills can be formed both in the classroom and outside of it. The advantage of using podcasting in education is their authenticity. On the one hand, students are familiar with their popular content; on the other hand they are receiving the interdisciplinary skills necessary for the use of a foreign language in real life. Moreover, students become more motivated because of the creative value of the materials offered.

Podcasts, or audio blogs, are distributed as separate files, or feeds, at the same address on the Internet, from where they can be easily downloaded into an MP3-player and listened to at the user’s convenience. The word podcast (podcast) combines the words iPod (MP3 player designed by the company Apple) and to broadcast. Hence, the term “podcasting” nowadays means “sharing audio or video on the Internet” [6, 480]. Podcasting means both producing and offering podcasts or video casts. This effective alternative to radio and television does not require any frequency licensing and is available at any time to the listener. As a synthesis of the benefits of Internet and radio (television), podcasting offers incredible opportunities for those who wish to listen to a speech in a foreign language and improve their language skills. An integral feature of the MP3 format is its versatility and availability: it can be recorded and played on computers, MP3 players, and even in modern car stereo

systems. Podcasting presents an ideal, ready-to-broadcast model: the records can be downloaded from the Internet and then listened to at home, in cars or at work. You can select the material of interest: audio diaries, funny stories, political debates or radio shows.

Foreign language teachers who use audio blogs in teaching regularly see two ways of use of podcasts: for listening and for creating information products in class or out of it. However, the essential task of podcasts in education remains to develop auditory receptive skills. Podcasting brings a whole new dimension to listening: the diversity of topics enables listeners to use them in all stages of their language learning. In general, the way we use podcasts coincides with the way we work with common audio texts. It requires a clear sequence of the teachers' and the students' actions (as in the "three-stage model of teaching of listening") [7, 45]: a preliminary pre-task briefing, listening and interpretation of information provided by podcast, and controlling the students' understanding of the text.

The innovation, purpose of the resource (the development of listening, writing, reading and speaking skills), and its creativity attract both teachers and students of language. Interaction can be both synchronous and asynchronous. The products are available at any time. This technical means can be employed both in the classroom and in the self-study. It is important to note the factor of fun and learning efficiency without pressure.

Recently, as the cognitive model of learning along with developing of language skills and communicative competence occupy the central place in language teaching, the so called "language learning awareness" [8, 182], which describes the processes of learning, focused on meta cognitive reflection on language learning, comes into centre of our attention. Similarly to conventional radio and television stations, podcasts are offered by online newspaper, institutions, universities, training centres, etc.

The Internet offers a lot of podcasts on both professional and general topics. Some can help students prepare for international exams, the TOEFL tests, while others are designed for students with low levels of language proficiency. Some even contain ready-made tasks for the students. It has been noted that regular listening to a text adapted to the student's abilities in the foreign language, has a systemic effect on all his other skills, including total literacy and their ability not only to understand, but also to speak in the target language.

The major genres of podcasts include audio blogs, or online diary, music podcasts, comedy podcasts, audio books, educational podcasts,

interviews, news, politics, radio plays, radio shows, games and sports.

To address the challenges of learning a foreign language deserves a special attention of educational podcasts. Now, many European and U.S. colleges and universities prepare their training podcasts. At the same time podcast are used by professors to spread information on the latest scientific advances, and by students to share their knowledge and other useful information.

Educational podcasts devoted to the study of foreign languages can solve a number of methodological problems, including formation of auditory skills, understanding native pronunciation, vocabulary expansion and enrichment, establishment and improvement of grammar, as well as enhancement of listening and pronunciation skills and development of speaking and writing skills.

When teaching speaking in the target foreign language, teachers should use this technology to its maximum potential, because in this context the language is both a means of communication and the object of study. Podcasts in learning and teaching contribute to:

- raising motivation to study foreign languages;
- free selection of the phonetic material according to interest;
- formation of listening skills and the ability to perceive different styles of speech with different accents and intonations;
- improvement of speaking skills.

Nowadays, students can take advantage of a number of web sites with podcasts designed exclusively for the study of the English language with content covering various topics. Based on their content we distinguish the following categories of podcasts:

1. Podcasts aimed at developing listening skills. Such programs include traditional listening exercises.
2. Podcasts aimed at conducting classes in English. Audio files of this type are designed to lead a whole English lesson and are usually accompanied by hand-outs and lesson plans.
3. Podcasts working with lexical material. This type is widely used, probably because of their simplicity: the author simply selects a word, phrase or idiom, explains their meaning and provides examples of their practical use in spoken language.
4. Podcasts accompanied by a secondary text. Synopsis of the audio file can be used to provide support during listening.
5. Podcasts-jokes are a playful way to make learning English more interesting and to encourage students to a particularly careful listening.

Podcasts-songs contain songs specially selected for the study of English as a foreign language.

6. Phonetics enhancing podcasts aim to practicing the pronunciation of English sounds and phrasal stress.

7. Podcasts-stories contain stories, usually accompanied by assignments to check understanding [11, 40].

8. Podcasts are applied as appropriate material for the development of speaking, training and monitoring of prepared and unprepared speech.

Increasing the efficiency of foreign language teaching, podcasts help to intensify, customize and organize the educational process. Podcasts develop the students' autonomy and their critical thinking. Moreover, as a mobile learning tool they implement active forms of learning, standards of modern education and student-centred teaching [9, 22].

Due to didactic qualities and doubtless results in teaching of foreign languages, podcasting can be used as a means of:

- Expanding the boundaries of the learning environment (learning in classroom and during extracurricular time);

- Organizing intercultural communication via the Internet;

- dissemination of educational material (lectures, additional course materials) created by teachers;

- Providing additional practice in target language for students;

- authentic information for students studying foreign cultures;

- Distributing administrative and organizational information, such as schedules and announcements;

- Revising materials from previous lessons;

- Preparing students for lectures and practical exercises;

- Reducing psychological difficulties in studying a foreign language.

Nowadays, podcasts are used in three following ways:

- 1) Onsite listening without downloading;

- 2) Listening after downloading to a personal computer, mobile phone, MP3 player, iPod;

- 3) Creating podcasts for further distribution to Internet users.

As part of the above-mentioned methods, when working with podcasts in learning a foreign language learner can also create podcasts for themselves without further publication, i.e. only for their training of pronunciation or intonation. It must be noted that to work with podcasts users do not need any special technical equipment, such as iPod, MP3 player and mobile phone, they only supply portability process of listening. Even without access to the Internet the user will be able to listen to podcasts on their computer. Podcasts can be

played to traditional language audiences from loudspeakers connected to any device playing podcasts from your own music library or the Internet. For audio casts such devices are phones, smart phones and iPods. In groups of 10-12 people video casts can be viewed on laptops and tablet computers. In a wider audience these devices may be used in combination with a stationary or portable projector.

Didactic potential of podcasting is based on key technical and didactic characteristics of the Internet:

1. Authenticity. A large number of podcasts are adapted to use in language teaching, with accompanying texts, manuscripts, notes on the level of complexity, and didactic recommendations, as well as assignments to the proposed passage. They can be used at different stages of learning a foreign language. When facing an authentic situation, students see the process of learning a foreign language as particularly exciting, motivating and effective.

2. Topicality. Podcasting system allows users to regularly update their archives with new audio and video content from the Internet. By signing up, their podcasts are automatically updated every day on their computers, with information on the latest developments in the various spheres of life. This information can be used in or outside of their classes.

3. Competence in the field of media. Podcasts are rather simple to use: you just download the podcasts you want in MP3 format to your computer or other media. Such technical possibility enables the students to explore new means of training and motivate them to further independent and group work.

4. Autonomy. One of the main advantages of the Internet as a learning platform is the autonomy allowed to the language student. They can adjust the use to their needs, to their pace of learning and level of knowledge. If students can themselves determine the conditions of their studying process, their learning outcome will not only match but even surpass the outcome achieved by traditional teaching methods.

5. Multichannel perception. Podcast service often offers training materials, which are based on a combination of a number of audio, photo or video images as well as text material. This makes it possible to use a single multiclass training materials, i.e. simultaneously involve different organs of perception, which, of course, increases the possibility of receptive students, is an important key to understanding the information in a foreign language, and as a consequence, the incentive to oral or written statements on the topic.

6. Mobility of the technical means (MP3 player) allows you to access the podcast content at any time and off campus, in this case to talk about expanding the learning environment.

Access to such funds, as a podcast, outside of training sessions a chance to study in their spare time and the opportunity to work in accordance with the personal receptive skills, adapt understanding of the complex audio passages to individual peculiarities of perception. This frees up listening to bad halo obligations or tasks of high complexity.

7. Multifunctionality. Podcasting system is multifunctional, it can help in learning a foreign language can develop several kinds of language skills: Listening, along with the classic is to improve current skills of oral and written language, besides podcasts provide knowledge about the diversity of the language and culture of the target language in a comfortable environment for the listener .

8. Productivity. Using of generic materials is one aspect of working with podcasts on the employment of foreign language and to create and redistribute their own podcasts – other. In terms of productivity podcasting is a strong impetus to the activities of a foreign language in terms of the activity approach. Creating and publishing network audio or video materials, students work with advanced information technology in the real world.

9. Interactivity. At the present stage of development of the Internet interactivity is the main idea of the concept of Web 2.0, according to which it is important not only consumption, but also the active interaction between people online. Integration of podcasting in learning a foreign language with its possibilities of cooperative interaction is the best format interactive learning process.

### Conclusion

The rate of development of modern information and communication technologies can talk about current and future of this area. Podcasting offers opportunities to ensure the quality of learning a foreign language because of the availability of this technology, cognition, self-intensification of work [12]. Taking all this into account, we can conclude that the podcast is a media source of information, along with other resources essential technical means of distance learning a foreign language, which allows solving complex problems of foreign language education.

In general, the technology podcast coincides with the technology working on audio texts and has a clear sequence of the actions of the teacher and students: a preliminary briefing and pre-task, the process of perception and interpretation of information podcast, job controlling heard understanding of the text. Selecting or developing an exercise podcasts aimed at the formation of auditory skills and skills of listening, consider the levels of different types of jobs.

Thus, the above features podcasts provide a new quality of the process of learning a foreign

language in high school, and was highly motivated students, initiative, commitment, thereby increasing the effectiveness of the educational process, and creates the conditions for the formation of the skills required in the modern graduate careers. Furthermore, the use of podcasts in learning mobility demonstrates the modern education system and timely adaptation to innovation.

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## DYNAMIC STUDY OF VOCABULARY OF THE RUSSIAN LANGUAGE: THE PROBLEM OF IDENTIFICATION AND CLASSIFICATION OF LEXICAL-SEMANTIC PARADIGMS

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The article is in the context of classic trends of modern Slavic studies – historical lexicology of Slavic languages – and is devoted to the description of diachronic lexical system of the Russian language from Proto-Slavic to modern state, based on a study of genetically and semantically close vocabulary combined in derivational, root and etymological nests. The author proves the possibility and necessity of a new complex lexical unit – lexical-semantic paradigm, which includes etymological nests, related by common origin and semantic interaction components.

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**Keywords:** lexical-semantic system, historical lexicology, lexical, derivational, root and etymological nests, lexical-semantic paradigm

In modern lexicology lexical nests (LN) are recognized as main complex (backbone) units of the lexical-semantic system of the language. Units and categories, not only of the lexical-semantic, and grammatical level of language: morphemic, derivational, morphological and syntactic are closely «intertwined» and constantly interact in the structure and semantics of its component lexemes. As a result of this interaction important thing for the semantic and structural transformations, very important for lexical nests take place. And they can lead to the splitting and destruction of the once unified nest. The study of linguistic and extralinguistic factors determining the formation, operation and decay of lexical nests is the most important task of diachronic word formation, which recognized as the most productive and encouraging the study of lexical nests throughout the history of the language. This approach allows us to identify the features of formation and functioning of LN, the specifics of the relationships between words within the nest, to set the static and dynamics in the studied nests, see the prospect of motion of investigated facts to a modern state. The study of semantic changes of words of the nest in their historical development helps to clarify the conditions of rupture of word-formation bond and converting derivational (DN) or root nest (RN) into the etymological (EN).

In the interpretation of modern etymologists EN includes «all genetically related words, regardless of the degree of transparency of these bonds at the current level» [4, p. 24]. Consequently, EN – is hierarchically organized according to the principle of derivational nest group of words of related languages (in the broadest sense) or one language (in the narrow sense), including all ever existed throughout the history of the given languages (or the given

language) reflexes certain reconstructed for Proto-basis root, relative to which the possible assumption of the genetic community. In other words, the words which lost their semantic commonality, form different derivational nests at a certain level of language development and are included in one EN. For example, disuse of the word *имати* ‘take, miss’ in the ancient language led to the formation of the modern Russian literary language of a multitude of independent DN-headed once prefixes derived from the verb – *внимать, вынимать, занимать, изымать, нанимать, отнимать, поднимать, понимать, принимать, приятный, снимать, унимать* and others, which form a single root *-им-//-ним-* bound around RN. Considering that the old Russian verbs *имати* and *имѣти* (modern *иметь*) are derivatives of the Proto-Slavic root words *\*ęti/\*jъmati* (*имати* ‘take, miss’, *имѣти* ‘enjoy what is taken under control’), word-forming derivatives of these verbs form one EN, originating from the Indo-European root *\*jъm-*.

Thus, reconstruction of EN, always involves reconstruction by various means (explanation of semantic differences, phonological identification, etc.) of lost derivational relations of words or groups of words, cf. such deetymological pairs as belonging to the above mentioned EN tokens *иметь, изыщный, наук, приятель, необъятный*, leading its origin from the Proto-Slavic root *\*em-*, described by the author in the master’s and doctoral theses and subsequent Pub of replication [7].

Monitoring of the development of synonymous LN *\*em-* ‘to take, to have’ и *\*ber-* ‘to take’ in the history of the Russian language we have allowed to develop in **a concrete material reconstruction technique of EN**. It comprises the following operations:

1) sample of data of the studied roots from etymological dictionaries of the Russian language, the definition of their semantics, phonetic variants and corresponding in related Slavic languages;

2) analysis of derivational nests presented in modern derivational and morphemic dictionary, in order to identify the most productive way for their derivation and most frequently used phonetic variants;

3) addressing to the explanatory dictionaries of modern Russian literary language for the purpose of a semantic description of the components of word-building nests;

4) sample of the idiomatic and dialectal dictionaries to supplement composition etymological nests with everyday colloquial words and obsolete because it is known that in the national dialects «vintage effects and special features of a particular language, dating back to earlier periods of its development, are often more accurately reflected or even better saved than in the contemporary literary variety of the language» [2, p. 46];

5) sample from historical dictionaries of the Russian language and etymological dictionaries of Slavic languages for the purpose of reconstruction of the EN staff for earlier periods of development of the Russian language: Proto-Slavic, Old Russian of XI–XIV centuries, Russian of the end of XIV–XVII centuries, XVIII – beginning of XIX cs.;

6) recovery of derivational nests with the test applied to the roots of the Proto-Slavic and ancient Russian state, in accordance with the relationships of formative derivative and semantic motivation within nests of words;

7) addressing to data of intelligent, historical and etymological dictionaries of related Slavic languages to replenish EN with words that have undergone significant changes in their phonetic, semantic and word-formation structure and were not included in the analyzed DN at modern level;

8) reconstruction by the method of filling the «empty cells» which were uncommitted by Historical Dictionaries of lexemes by comparing identical in structure elements derivational nest (derivational pairs or chains), belonging to the studied root groups, as in accordance with the basic rule of etymological analysis, the explained word has to be considered as a member of a certain word-formation series, forming a particular regular model, thus in the etymological analysis it should be considered that the word as a certain structural whole is a member of the word-forming system of the language in general and it always appears in the language

(if not borrowed from the outside) as a unit of a specific word-formation type, belonging to a certain lingvochronological level.

Analysis of EN in general, in all the diversity of its constituent words of derivational relations, very relevant from the point of view of studying the typology of breaks of derivational relations, transforming the DN into the etymological. The causes of these gaps and their reflection in the formative structure of the dispersed parts of the same DN is very diverse. It was noted by many etymologists [3, 6, 9] that this gap is almost never full during the decay of a single DN into several separate groups of words after deetimologizatsii (i.e. phonetic transformations and/or semantic changes) – the former unity never disappears without a trace. The presence of former word-building links from some time independent groups of words indicate the formation of derivatives, the external shape of which follows the phonetic form of one group and the meaning of «borrows» from another separated group of words. For example: on the origin of the word *изящный* it connected with the Slavic verb \*jъzęti (cf. Old Slavic *изъати* ‘to extract, to remove, to take out’, Russian *изъять*), which in turn is derived from the Proto-Slavic prefixes the root-word of Indo-European origin \*jęti (\*jъmo), indicating the effect of familiarizing object ‘to take, to seize’. The basis \*jъz-ę-t-j-ъn- with an unusual combination -tj- instead -t- was formed under the influence of forms of present participles ending in -ę-t-j- : -o-t-j-. Thus, the model of the semantics of the word *изящный* ‘graceful’ in the history of the Russian language can be represented as follows:

‘to take, to seize’ (*имати // ати // няти*) →  
 ‘to take out of anything, to select’ (*изъати // изъяти*) →  
 ‘chosen’ (*изъаты // изъяты*) →  
 ‘constituting an exception, extraordinary, i.e., so that you can select, highlight out of a number of these by special, exclusive features’ (*изъаты // изъяты* – substantivized form) →  
 ‘characterized by proportionality refined form that meets the requirements of fine artistic taste’ (*изящны // изящный*) →  
 ‘that corresponds to the idea of subtle beauty that embodies the beauty’ (*изящество // изящество*).

Moreover, this semantic model can be considered as a language universal, at least for a number of Indo-European languages, cf. the Latin *eximius* ‘excellent; exceptive’, formed from *eximō* < *ex-em-ō* ‘take out’,

from here *exemplum* ‘sample’; French *elegant* ‘elegant’ from the Latin. *ēligō* < *e(x)* + *legō* ‘kick, I choose’.

Alike forms chronologically preceded by dissociation of etymologically related lexical groups. This fact again leads to the conclusion about the need of dynamic study the semantics of the entire array of genetically close vocabulary component of the EN, especially that the very formulation and consideration of deetimologization is the proof of the close connection diachronic and synchronic aspects in the study of lexical nests. As a result of deetimologization the nests, which united lexical units on the basis of word-building relationships undergo changes that lead, on the one hand, to the complete disintegration of the DN and its conversion into RN or, on the other hand, to the loss from the DN of individual members which continue in the future independent development or exhaust in a passive vocabulary of the language.

Dynamic (synchronous-diachronic) approach to the study of the semantic structure of the entire LN enables to trace its operation in the history of the language and explain many of the facts of its current state. In this regard, one cannot but quote the article L.A. Sergeeva: «Within the cognitive approach semantic fields are not sufficiently comprehensive to describe the mental lexicon, it is necessary to use a larger associations of words, reflecting, in addition to community different types of things, and thesaurus link words, showing different patterns of cognitive processing of data on the real world and mental world of man» [8, c. 150].

Indeed, in the historical development of the vocabulary of the language it can be found even larger system formations than EN. Thus, in the course of study of Slavonic and Old Russian lexical semantics nests \*em- and \*ber- ‘to take’ was an association of their meanings with the semantics of lexical nests \*dō- (*давать*, *дать*) and \*nesti (*to carry*). Semantic variety formed by the vertices of these lexical nests, we called **the lexical-semantic paradigm** (LSP). Supporting words of this series (*давать* → *дать* → *брать* → *взять* → *иметь* → *нести* → *давать*) are combined by the sequence of meanings they express, containing common Semes: ‘to attach the object’ and ‘action of the subject, aimed at the object to attach’. Semantic intersection of these lexemes is due to the syncretism of ancient roots, which they ascend:

– i.-e. \*dō- has the meaning ‘to give’, ‘to take’, ‘to bear’ (cf. manifestation of communication meanings ‘to give’ and ‘to take’ in the Bulgarian idiomatic combination *имам*

*вземане – даване* ‘have common business with someone’);

– i.-e. \*bher- ‘to bear’ (here later *брeмя*, *берeмя*, *берeменная*) in Slavonic develops ‘to take’, becoming synonymous with i.-e. \*em- ‘to take’;

– i.-e. \*em- ‘to take’ later it acquires the meaning ‘to have’, existing in parallel with the original throughout history of the Russian and related Slavic languages.

The relationship between the concepts of ‘to grab’ and ‘to have’ is seen in a variety of languages with very different initial roots: German *haben* ‘to have’ is related to the Latin *capere* ‘to suffice’; Russian *иметь* and Russian dialectal *имать* ‘to take, to snap, to catch’; Lithuanian *turėti* ‘to have’ and *tvėrti* ‘to suffice’, and the Latin verb itself, indicating the ‘to grab’ in the same way is connected with the verb ‘to have’. In other words ‘to have’ is the result of ‘grasping’.

This semantic syncretism can be explained by the fact that “language was born not out of the need to give things names, but from the need to refer things to somebody’s team, to impose on them his or her” brand. «The first word did not mean things, but their attitude, real or imaginary, to the team. Naming was an act of some kind of “assignment”. “Not only the tools and products were assigned, but also such distant and inaccessible things like the sky and the sun. Cf, for example, in Zulu *i-zulu* ‘Zulu’ and *i-zulu* ‘sky’” [1, p. 235]. Thus the vocabulary comes to the fore in the cognitive aspect of the language, the vocabulary is its being passed through the public consciousness. As social relations, relations of people to each other impose certain imprint on the formation and the work of consciousness. The subject of consciousness is not an individual act, but the staff, and everything around is realized and evaluated in terms of collective interests. This can explain the origin of our paradigm, the key verbs of which indicate actions that are perceived not by themselves, but in the circle of people: one conveys something else to the property, the other, in turn, assigns the item to the property, or carries it and gives it to someone else, etc.

The intersection of the meanings in the reflexes of key words of the lexical-semantic paradigm can be observed in modern Slavic languages. Thus, the presence of additional Seme ‘to bear’ is marked in the root meaning of the verb group \*em-:

*снятьcя* ‘leave any place, going on a journey’, colloquial. ‘To go, to go in any direction’, ie «to carry yourself in any direction»;

донять 'to reach, to get to someone', as well as in the semantics of the verbs belonging to the lexical nests \*em- and \*ber- in the related Slavic languages:

Bulgarian *добера се* 'to reach', *емна, поема* 'to go somewhere else';

Polish *dobrać się* 'to get', *przebrać się* 'to get', *zabrać się* 'to gather, to go, to get out'.

Cf as a manifestation of the semantics in 'moving in space' in the modern DN with the vertex *нести*:

*вознестись* stylistically high 'to climb up',  
*донестись* stylistically colloquial 'to fast connections',

*нести* 'to move very fast, to move, to race',  
*перенестись* stylistically colloquial 'to cross fast, to move, to fly through anything, anywhere; come tearing';

*пронестись* 'to speed',

*унестись* 'to leave quickly, to dash away',  
and also forms a non-reflexive *донести* 'to deliver quickly', *нести* 'to move swiftly, to rush'.

Besides semantic syncretism, the existence of such a lexical-semantic paradigm is due to well-known in the comparative grammar of Slavic and other Indo-European languages paradigmatic phenomenon Suppletion described by O.N. Trubachev: "i.-e. \*bher- 'to bear' acted in the durative-present function, while in functions of other verb tenses it was filled by a very special etymological basics – i.-e. \*(e)nek-, \*(e)l-, including etymologically obscure cases: Greek φέρω 'I carry, wear', τλῆναι, ταλάσσαι, Latin *ferō* 'I carry, I wear', perfect form *tulī* < ancient Latin *tulō*, *tulere* 'to wear, to bring' (original 'to lift, to withstand the severity')" [10: c. 321]. Similarly, the written history sees some facts of destruction, leveling of suppletive when lexical independence of stems becomes predominant over their grammatical relations. So, \*bher- and \*(e)nek- in Slavic languages are completely separate lexemes with specific meanings \*berQ, \*bъrati 'to take' and \*nesti 'to bear', and only the old verbal nominal derivatives like \*bermę 'the burden', show that the Slavic languages preserve the memory of old suppletive relationship, cf Serbo-Croatian *nésti*, *nésem* 'to carry, bear' and *zànijeti* 'to pregnant'. It is in the latter form that distinctive preservation of linguistic fact of great antiquity is occurred.

Thus, the ratio of the components of our semantic lexical-semantic paradigm can be presented as a scheme:

*дать* // *давать* (action verb, donativ verb) →  
*брать* // *взять* (familiarizing object verb) →  
*иметь* (verb of possession, possessive verb) →  
*нести* (verb of movement in space) →  
*давать* // *дать*

In view of modern cognitive approaches to semantics, it can be stated that the lexical-semantic paradigm is a transmission image of the chart – get – possession, which is a semantic universal and its specific lexical and grammatical expression in a particular language is an indicator of the national language picture of the world.

Consideration of the changes that occur in the process of development of lexica system of the language makes lexical-semantic paradigm an important object of historical lexicology. It is in large lexical associations that we can identify and track communication and interactions between words and their intensification or weakening, changing of fields using words of that language, their functional stratification, that is, all the changes that occur in the lexical system. One way to solve the problem is to create a complete and systematic essay of Russian historical lexicology considering the dynamics of the whole complex of lexical nests in the whole period of their existence as part of the LSP, because linguists have long noted that words with similar meanings had similar semantic history. From this it follows that the study of lexical nests and then larger associations (LSP) is actual both in a synchronous and diachronic aspects. In the synchronous aspect lexical system can be studied in order to describe it in relation to any specified period of historical language development, in diachronic – in order to reproduce the development process of this system, from the ancient era to the modern state.

In the light of the above, it should be stressed that history of language vocabulary as a whole, history of LN of every single word is related not only to the external history of the people, but also with the history of his thought. On the other hand, by their organization lexical nests show one of the fragments of a language picture of the world, as the underlying derivation and semantic development of a LN direct (denotative) meaning of top-word, assumes the function of the linguistic representation of some fragment of the subject-conceptual field of the reality that in general is peculiarly dismembered by a certain set of lexical units and their word-building bonds in the structure of the LN.

In conclusion, we emphasize: due to the fact that word formation is a means of linguistic conceptualization of the picture of the world, its main structural component of the lexical nest is not only classification unit, but a unit of language consciousness and communication, so that we come to understanding of



a language picture of the world not as a single, easy to analyze the vocabulary fragment, but as a comprehensive Synergy-cal picture, as a holistic picture language of everything that exists in and around us. Such understanding requires the term *picture of the world*, for which is the idea of language ability by its own means to present all that exists as an entity, accommodating in a single visual space and this space combined.

Taking into account the opinion of V.B. Kasevich [5] that language evolves slowly, and it is natural to expect that its semantics to a greater extent reflects those vestigial ideas and knowledge, that picture of the world that was peculiar to this ethnic group at a sufficiently early stage of its development, and should be recognized as a diachronic approach to the study of the lexical-semantic language system is more efficient and productive, and comprehensive study of genetic and semantically similar lexical highly complex associations on the axis of successive levels lingvochronological accordance with the spirit of understanding of dynamic picture of the world. Studying and describing lexical nests in diachrony, you can overcome the barrier of «fear» to the volatile mobile zones occurring in the language system in the process of its development and changes, as in the nest with its strict organization in accordance with the principles of the semantic motivation and formative pro-derivatives not only already established («standing») token, and the newly formed, and stretching into the passive

vocabulary («mobile zone») find their certain place. Thus, the study of etymological nests and lexical-semantic paradigms «reconciled», find their equally important and complementary use of the two linguistic paradigm – system centric and anthropocentric.

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## THE CONCEPT OF A NEW EDUCATIONAL-METHODICAL COMPLEX ON NATIONAL HISTORY: A NEW LOOK OR A RETURN TO TRADITION

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The article seeks to highlight some of the provisions of the “Concept of a new educational-methodical complex on national history”, which by order of Vladimir Putin, was developed and approved by the Institute of Russian history. “Concept” will become a standard teaching correlator educational programs, control measuring materials and textbooks on national history. The paper presents the analysis of the methodical principles of organization of educational process on the lessons of history, proposed by the authors of the Concept, as well as evaluation some “difficult issues” made by the authors of the Concept in the discursive field for discussion on the lessons of history with the purpose of formation of the analytical skills of students.

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**Keywords:** concept of national history, the history of Russia, difficult questions of history of Russia, methodology of history teaching, textbooks on history of Russia

History occupies a special position among the other Sciences of society and man, because this science, like no other, offers the choice of strategy of development of the state and forms the necessary qualities of a personality, allowing to support the political body formed within certain boundaries of patriotism and citizenship.

Realizing this, in the period of the Soviet Union, the government has made history as a science and as a school discipline in “the servant” ideology. It caused irritation, especially among the intelligentsia, calling not hesitate to tell the youth “historic truth” without diluting the facts.

In the 90-ies on the wave of democratization of public life and the fight against totalitarian past history as a school subject has ceased to perform its traditional role of education of patriotism among the younger generation. In the organizational-methodological terms, this has led to the emergence of many textbooks, the authors outline the history as they understand themselves, adhering to one or another scientific concept, a historical event, or fulfilled the order. For example, the support Fund of the notorious D. Soros was issued a huge quantity of literature, which gradually but insistently, taught the younger generation the idea of Russia as a despotic state, the vast freedom of the person, and only with the coming to power of the B.N. Yeltsin the country has the opportunity to build democracy and to converge with the leading countries of the world, so to say “join the family of civilized Nations”.

In the end, society is faced with a situation where the school has been unable to respond to the challenges of the social environment, which should be understood as a set of institutions such as the media, youth and andegradnyn flow. The result was a change in the conscious-

ness of young people associated with the loss of social ideals and focus purely on customer value, and formed the so-called “lost generation”, not remembering the great deeds of their ancestors and not reading the great works of A.S. Pushkin, L.N. Tolstoy, Dostoevsky, etc. To break this trend of leveling of values in the minds of the youth is possible if they are clearly formulated at the national level. But this is impossible with a fragmented view of a civilizational identity (as, in fact, where is our place in the West, in the East, or somewhere in between), understanding the prospects for further development.

In this environment, President Vladimir Putin instructed to develop the Concept of a new educational-methodical complex on national history. Its main task is to unify the representation of the historical process in the educational literature and to give a balanced, if possible unbiased, estimates passed, the historical path of Russia. Thus, on the one hand, at the level of government realized the need to return to history as a school subject its educational function, and promote clearly articulated at the national level, the principles of understanding your place in the world and its historical path, and on the other, to preserve the variety of views about certain historical events, which there are discussions of historical scholarship. Consider some of the provisions of this document.

From a methodological point of view, not to mention the attempted universalization approach to the development of educational materials on the history including educational syllabus, textbook, teaching AIDS, books for teachers, a set of cards, electronic applications. Implementing this approach will avoid dissonance between the textbook, as a rule, a small

number of tasks to educational material (paragraph text), and other teaching materials. Notes an attempt to solve this problem currently, the development of materials to the textbook written by a particular author. However, it can be called insufficient, because teaching materials to the textbook are presented, as a rule, different authors and do not represent a single educational-methodical complex (for example, to the textbook can be added developed a guide for teachers, other educational materials do not exist, or, conversely, presents the tasks to the textbook in the absence of other components of educational and methodical material).

The course of history in schools must implement the competence approach, in accordance with which the study of the subject, in addition to the aspect of socialization, intended to form and develop such skills in students how to analyze contained in the various sources of information about events and phenomena of past and present, to review developments in accordance with the principle of historicism, in their dynamics, interrelationship and interdependence, to apply historical knowledge in academic and extracurricular activities, in a modern, multicultural, multiethnic and multi-religious society [Concept]. A key strategy of learning the Concept developers identified individualized learning and differentiated approach. In this Concept the authors follow the innovations of the 90-ies of the last century when educational theory was developed, and in teaching practice implemented various training technologies. These include: personality-oriented technologies, focuses on the subjectivity of the student into account his age and individual abilities; modular technology, promoting the development of students' independence, their ability to work with individual ways of development of educational material; – level of technology, orienting the learning process to individual students' ability, etc. In the Concept we are talking about differentiation of tasks by level of difficulty, which allows you to organize educational-cognitive activity of students based on their real ability, which creates favorable conditions for the development of children through education. The differentiation of tasks can be as "wide", aimed at the potential of the selected group, and "narrow", focusing attention on the potential of the individual student. Multilevel job can be additional, beyond the lesson topics (report, summary, message, answer to a difficult question or solving the problem) and fixed (this job is on the cards, and differentiated survey of independent and control work, etc.). Criteria for different lev-

els of tasks may be not only the complexity, but focus. Namely: for those students who like to think, it is possible to propose a theoretical task; for those students who are not interested in the subject, such as history, but on math it is possible to find jobs where the need to attract knowledge interesting discipline; for those students who are not interested in any subject is to find a job savvy, puzzles, crosswords, etc.

Implementation of the competence model of building the educational process in the school also contributes to the reduction in the number of paragraphs (about a third) compared to the number of hours allotted for the course. From the point of view of the authors of the Concept this will allow time for other activities and not only on the tutorial (expansion – implementation of the activity approach in education that was widely used in 90-e years in school).

A significant innovation will be the transition from the concentric system of the study of history, when at the stage of basic education completed the process of mastering new material, and in high school on a deeper level mastered difficult concepts and phenomena of history, such as "feudalism", the "Asiatic mode of production, Oriental despotism", etc., have formed a holistic view of the laws of historical development, to linear: the study of the history will be from 5 to 10 class and 11 class may be offered system course "History of Russia in the global context". The implementation of this approach may contribute to a more coherent study of historical events, but violate well-established principles and approaches to the teaching of history in school.

The greatest interest in the Concept is the last section called "Hard questions". It presents a list of topics on which science and society debate. These included all the key events of the 20th century. It and is clear: the past century was a turning point in our history. Two times we changed the vector of its development: in 1917 and in 1991. Russia participated in the two world wars. For a short period became a superpower. But the UPS was accompanied by unprecedented sacrifices for our country. Of course, to give an unambiguous assessment of such events, especially due to the fact that time was not so much impossible.

Revealing from our point of view is the fact that inclusion in the "tough issues" of the era of Peter the Great, during the 19th and 20th centuries, valued primarily from the standpoint of the Westerners, i.e. as a time of modernization breakthrough, carried out by the genius and perseverance of one man, who managed

to break the resistance of the narrow, superstitious and lazy citizens. Modernization of Peter, its apparent success was correlated in the Soviet era with the transformation of the Bolsheviks, especially the so-called “Stalin’s modernization”, also estimated an unqualified success brilliant policy leader. In the 90-ies the era of Peter the Great was assessed as definitely positive phenomenon primarily as a time of rapprochement with Europe, which is clearly associated with politics young reformers surrounding President Boris N. Yeltsin. The authors of the Concept propose to compare and evaluate the success and cost of these successes and on the basis of this comparison, draw your own conclusions.

“Tough question” № 1 is “the formation of Ancient States and the role of the Varagis in this process”. The authors of the Concept refer to Soviet historiography, the so-called “Varangian question”, whose decision was limited to the identification taking the reasons for the formation of the state among the Eastern Slavs, namely external (the influence of the Varagis) or internal (processes of social differentiation (class formation) and the emergence of the ruling elite, gradually separated from freemen and seeking to maintain its position among the tribesmen). The ethnicity of the Varagis was defined by far for sure: the Varagis – it Scandinavians, the Vikings. Meanwhile, the preservation of this issue misleads students, creates a distorted view they have about the process of formation of their own state, because it is well known that the question about the ethnic origin of Varagis in science is not settled. In this regard, the formulation of the question in the textbooks should guide students not primarily on defining the role of the Varagis in the process of politogenesis among the Eastern Slavs, and to the discussion of Norman-

ists and antinormanists, the arguments of both. You need to show alternative solutions of the Varangian question, and challenge students to decide for themselves the conclusions. Otherwise we risk to face with an endless stream of myths Normanists in the history books, leading to the emergence of such interpretations, which are represented, for example, in the manual for students of humanitarian universities and high school students, authored by R.G. Skrynnikov. According to his views, Ancient Rus, in the usual sense, did not exist, and instead it was the so-called Eastern European Normandy.

New methodological approaches to understanding the historical process in our country the Concept interlinked with the revival of conservative ideological dominants to ideological consciousness among students in terms of the perception of native history as a succession of great victories, and the heroic deeds of their ancestors, worthy of love and imitation. History, as in the Soviet textbooks (remember, especially the coverage of events of the great October revolution, for example in the textbook under the editorship of A.M. Pankratova, 1952), have once again become the “pathos” of [Concept]. The authors urge not to gloss over the tragedy of our history. However, it is necessary to emphasize that Russian and other peoples of our country found the strength together to overcome fell to their share of the ordeal [the Concept].

Thus, the Concept summarizes those methodological principles that have been actively used in educational process at schools, since the 90-ies of the last century, maintaining the principle of variability in the assessment of certain historical events, but on the other hand there is a clear tendency to the glorification of the historical past of Russia. The latter circumstance can not but rejoice.

## DYNAMICS OF THE DEVELOPMENT OF SOCIAL INTEREST IN CHILDREN WITH SPECIAL NEEDS RAISED IN INSTITUTIONS

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Social interest, which is defined within the paradigm of Individual Psychology as a sense of cooperation and a striving to establish mutually beneficial relations with other people, first emerges from the bond between mother and child. The mother's task is to impart and cultivate certain qualities in the child that facilitate the process of adaptation of the individual to the environment. Our study of children with special needs raised in a social institution from 0 to 3 years of age is focused on analyzing the consequences of medical disorders and abandonment on the psychological and social development of children, and in particular on the development of social interest.

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**Keywords:** social interest, children with special needs, children with disorders, prematurely born children, social institution

The concept of social interest plays a key role in the theory of Individual Psychology and reflects the deep belief of its founder A. Adler that people are social beings and if they want to understand themselves better, they ought to take into account their relationships with other people and the social and cultural context in which they live [5, 174].

This concept reflects to a great extent the basic beliefs of A. Adler about the nature of this powerful driving force, which underlies all human strivings. The terms "social interest" is derived from the German neologism *Gemeinschaftsgefühl*, whose meaning is impossible to translate into another language with a single word or short phrase. It encompasses concepts and ideas that can be partially understood using phrases like "social feeling", "community feeling" or "sense of solidarity". It also includes the idea of membership in the community of human beings, a sense of self-identification as a part of humankind and a sense of alikeness with all representatives of the human races [5, 174].

A. Adler maintains that the preconditions for the development of social interest are innate. Like other inherent dispositions, social interest does not appear automatically, but requires conscious effort to develop.

Social interest develops in the social environment and the other people contribute to this process. The mother is the first person who plays an instrumental role in the development of social interest because the contact between her and the child is the first interaction in the baby's life and exercises the most influence [1, 45]. Her task is to foster in the child a sense of cooperation and a striving for interaction and relations of friendship – qualities that A. Adler regards as intertwined. Social interest facilitates the individual's adaptation to the environment. A. Adler also considers social interest as

a "sense of belonging". According to him, all human failure is attributable to a lack of social interest. He believes that people lacking in social interest approach the tasks of work, friendship and love without the conviction that they can solve these problems through cooperation [3, 138; 155–156]. When social interest is underdeveloped, the individual becomes too selfish and feels like he is a "nobody", a person completely helpless in the face of the challenges posed by the surrounding world.

Our study, which involves special needs children raised at a Children's Medical and Social Care Home from birth until the age of 3, is focused on the analysis of the effects of medical disorders and abandonment on the psychological and social development of the child and in particular on the development of social interest. The research employs the standardized test developed by V. Manova-Tomova, which is based on the Brunet-Lezine test for assessing psychomotor development of a child from 0 to 3 years of age [6, 38].

The analysis of the different measurements of psychomotor development, namely motor skills, speech, socio-emotional development, habits and pre-representational activity, in children with special needs raised in a social institution shows a delay in a number of different aspects, which is most pronounced in regard to speech development and pre-representation activity. Most of these children have not grasped the rules of language and only possess a basic vocabulary consisting of a couple of words; they can formulate simple but agrammatical sentences and demonstrate poorly developed communication skills. Some of the main reasons for the children's psychological problems can be traced to the abandonment by the parents, the absence of the mother, who is the most significant figure in a child's life, and the

effects of the medical disorders they have been diagnosed with.

Children with special needs who are brought up in institutions demonstrate low levels of activity, limited and poor contacts with adults, and, even though they have been surrounded by peers since early childhood, they fail to develop healthy and meaningful relationships with them.

The delay in speech development is the most obvious sign of psychological deprivation and it is most pronounced at the end of the second year.

Despite the excellent living conditions, the high-quality food and the medical care, the living environment is not authentic.

The goal of the study is to investigate the dynamics of psychomotor development and the specific characteristics of communication in early childhood in children with special educational needs raised in a social institution.

The subject of the study are the specific characteristics of psychomotor development and communication in young children with special needs raised in a social institution.

The participants in the study are 65 children with special needs, divided into two groups:

1. Children with disorders, who have been given a diagnosis, aged between 15 and 36 months – 15 children.
2. Prematurely born children between 0 and 3 years of age – 50 children.

#### Materials and methods of research

The following methods were used to meet the specific requirements of the study:

1. Psychological test for evaluating psychomotor development in children aged 0–3 years old developed by V. Manova-Tomova [6].
2. Pedagogical observation conducted simultaneously with the testing.
3. Discussion with members of the medical and non-pedagogical staff to collect their impressions concerning the development of the children included in the study.
4. The research employs V. Manova-Tomova's test for assessing the psychomotor development of a child from 0 to 3 years of age. It contains four evaluation criteria for the psychomotor development of children up to the age of 1 (motor development, sensory activity, socio-emotional development and speech) and six criteria for children aged 1–3 years (motor development, skills, habits, representational drawing, socio-emotional development and speech).

#### Organization of the study

Every child underwent individual observation. The children's performance with regard to the criteria for psychomotor development was studied.

The mathematico-statistical processing of the results requires the application of the evaluative logarithm "quotient of development", which is a function of the chronological and the mental age of the child.

$$QoD = \frac{DA}{CA} \cdot 100,$$

where *DA* – refers to developmental age; *CA* – means chronological age; *QoD* – signifies the quotient of development. The method used to calculate the quotient of development is based on roughly the same principles as the IQ test.

#### Results of research and their discussion

The results present the data on the individual characteristics of the observed children, which include the quotients of general psychomotor development and the communication skills of the children with special educational needs. The indicators used in this study are the following:

- Range of normal psychological development during early childhood.
- Mental age.
- Quotient of Development.
- Evidence of delayed mental development in children included in the study.

The primary spheres that characterize early childhood psychological development are analyzed. They are connected with the development of speech and communication, socio-emotional development, play, pre-representational activity, habits and motor skills.

The study employs the classical method of quantitative evaluation of psychological development through the quotient of development, which is derived from the comparison between the mental and the chronological age. The numerical value of this relationship is termed "quotient of development" (QoD).

The different values of the quotient of development obtained in this study allow us to determine the level of psychological development.

Table 1 presents the individual values of the quotient of development in children with early childhood disorders raised in an institution. The following abbreviations are used in the Table:

CP V. Manova – Tomova [6] – Cerebral palsy

NPD – Neuropsychological development

The values of the Quotient of Development are expressed as percentages.

The results of the study show that the quotient of development for the observed children with diagnosed disorders raised in a social institution between the ages of 15 and 36 months falls in the range between 28 and 75%.

The comparison between the values of the quotient of development over the course of the period of observation shows that the general quotient of development in children with diagnosed disorders decreases slightly at the end of this period. The decrease is dramatic only in one of the children – QoD falls from 48 to 28% due to a sharp deterioration of the child's health.

Table 1

Values of the Quotient of Psychomotor Development  
in children with early childhood disorders raised in institutions

Number	Diagnosis	Age in months	General QoD (%)	Speech QoD (%)	Age in months	General QoD (%)	Speech QoD (%)
1.	Microcephaly	15	48	13	24	28	17
2.	CP, deaf	18	53	18	30	36	20
3.	Delay in NPD	21	57	29	36	36	30
4.	CP	24	64	46	36	65	50
5.	CP	18	42	33	30	31	33
6.	Delay in NPD	18	61	39	36	43	31
7.	Delay in NPD	24	61	31	36	46	34
8.	Oral cavity deformation	18	75	61	36	78	67
9.	Hydrocephalus	21	60	50	30	57	57
10.	Hyperviscosity syndrome	21	50	38	36	47	36
11.	Retinopathy	15	42	40	36	45	43
12.	Delay in NPD	18	47	41	30	43	43
13.	CP	21	67	51	36	60	58
14.	Spina Bifida	16	60	59	30	73	67
15.	CP	15	68	50	36	75	57
Average values of QoD			55	39,9		50	43

The results demonstrate that the values of the quotient of development are strongly related to the children's diagnosed disorders.

The results show that the average values of the quotient of speech development in children with diagnosed disorders are lower than the average values of the quotient of general psychomotor development. At the beginning of the observation period, the average quotient of general psychomotor development of children with diagnosed disorders stands at 55%, while the average quotient of speech development is 39,9%. At the end of the observation period, these values are as follows: average quotient of general psychomotor development 50%, average quotient of speech development – 40%.

The results for prematurely born children, shown in Table 2, are similar. Even though they have not received a diagnosis, at this stage of their development they also have special needs because of their preterm birth, which requires special care. Overall, the average values of the quotient of development in this group are higher than those in the children diagnosed with disorders. These values, however, are still much lower than those of normally born children raised in a family. The lowest values for prematurely born children are seen in speech development again, where the average value of the quotient of development is only 51,42%, which can be characterized as critically low.

Table 2

Average QoD of psychomotor development for prematurely born children raised in institutions from 0 to 3 years old

	Criteria	Average quotient in %
A	General psychomotor development (PMD)	74,66
B	Speech	51,42
C	Motor development	85,48
D	Sensory development	70,00
E	Socio-emotional development	82,50
F	Skills	81,39
G	Habits	79,13
H	Representational drawing	63,42

### Discussion

The analysis we performed shows that development is an irregular and uneven process, especially in early childhood. It depends on the intensity of the external influences, as well as on the power of the internal dispositions and the rate of maturation of the nervous system. The results of the research we conducted lead to the inference that the quotients of development in children with special educational needs who are diagnosed with disorders or are prematurely born and raised in institutions decrease over the course of early childhood. The results of this study demonstrate that the quotient of psychological development in children with special educational needs brought up in institutions is determined by the extremely complex interaction between the internal conditions, i.e. the overall state of the child, and the external impact of the environment.

The children with disorders included in the study manifest a lower quotient of development, which is linked to the slower rate of compensation in their development.

The decrease in QoD noted during certain periods of their development is not caused by a general delay in all tested indicators. In most cases, it is the result of a delay in one or several indicators that are heavily influenced at certain times by the institutional form of child rearing.

One of the main reasons for the lower levels of QoD in children with special educational needs raised in an institution could be the insufficient social and emotional interaction at the institution, as well as the lack of diverse experiences in the environment that would otherwise stimulate sensory activity.

The low level of the quotient of speech development is especially pronounced, which indicates a poor grasp of the rules of language, resulting from an environment that does not sufficiently stimulate language development.

The primary driving force behind speech development during that period is the emotional environment in which the child is growing up, his attachment and affection for the people closest to him: the child imitates his loved ones, he wants to understand what the people who are constantly around him and in contact with him are telling him. However, this type of influence is far too limited in a social institution.

The values of the quotient of speech development in children with special educational needs are the first to decrease in ontogenesis.

Very few of these children can reach the values of this quotient for normally born and healthy children.

Our observations show that the first words appear at approximately the same time in normally developing children and in children with mental disorders, but there are significant differences when it comes to formulating the first sentences and mastering the rules of grammar. The first phase of speech development in a child between the ages of 1 and 3 years consist of uttering single words. The emergence of the first words and the accumulation of additional vocabulary is a long process for children with special needs raised in institutions. In many cases, these words are not fully vocalized or they are not fully understood by the child. In an attempt to fulfill his wishes, the child with special needs learns words such as “give” or equivalent gestures of indication. The process of learning the names of the surrounding objects only begins near the end of the second year of life.

During the second phase of speech development, which roughly coincides with the first half of the second year, the child can express a wish with a single word, tries to connect two words in the form of a sentence and asks his first questions.

Once they have acquired a vocabulary of 5–6 fully understood words, the observed children with special needs can use these words, but very few of them can formulate a sentence. One and the same word could have a different meaning depending on the intonation, the child’s body language and the situation in which it is uttered.

Almost half of the special needs children included in the study have not developed independent speech. The average level of speech development among these children at the age of 2,5 to 3 years old corresponds to the speech development of normally born and healthy children at 40 weeks old (Table 1). The time when the second phase appears and the extent to which it is fulfilled depend not only on the rearing and the social conditions in which the children with disorders are developing, but also on the development of their medical condition (the emergence of secondary disorders).

The vocal characteristics of speech are also affected by the conditions of deprivation. Babbling in babies develops under the influence of the speech they hear and the emotional interaction. Both factors are limited in a social institution, resulting in insufficient stimuli. The “complications” in the development of the vocal characteristics of speech that appear later in life are connected with unclear pronunciation and speech sound disorders. They are caused by the lack of opportunities for children with



special needs to practice their speech and the lack of specialists in this field working at the social institutions.

The third characteristic of speech, namely the social one, is also deeply affected. Children experience difficulties mastering speech as a means of communication.

The analysis shows that there is a discrepancy between the children's speech expression and the actual social situation. According to K. Marinova, most children living in an institution are not able to convey with words their experiences, feelings, emotional states [7].

According to F. Daskalova, from the perspective of psycholinguistics the moment when the first two-word sentence is uttered and used in the child's communication is considered a marker of having learned to talk [4].

The delay in speech development in children with special needs raised in an institution affects all aspects of speech.

A.A. Rean claims that emotional detachment, uncommunicative behavior and self-isolation could be caused by the development of hospitalism and emotional deprivation in the child [8, 76].

The research and observations on the psychomotor development of special needs children show that even when they have the same diagnosis, their individual development is different. This supports A. Adler's thesis that the development of children with different disorders is unique for each individual.

Having obtained certain results from our research, we attempted to interpret them using established theories.

A number of authors like H. Wallon (1988), T.B. Brazelton (1982), N. Verrier (2005) and D.B. Chamberlain (1988) explain to some degree why the loss of the mother causes a delay in the general psychological development of the child, but no explanation has been provided as to why this delay is most pronounced and critical in terms of the development of speech. Obviously there is a good reason why A. Adler emphasizes the irreplaceable role of the mother for the development of social interest in the child.

Speech is a special human ability with many important functions and it can develop only in the presence of other people. One of its most significant functions is the interactive, social function, which directs and expresses the child's interest towards other people. Adler claims that: "Speech...is not achieved by an individual, but emerges from the cooperation of all. Speech would be unthinkable without interest in others. Speech is a connection between two or more people to communicate what they mean" [2, 172].

A. Adler emphasizes the importance of speech and language for the cooperation with others. People are social beings and communication lies at the heart of social interaction and the development of social interest. This idea is the basis of the key concept of Individual Psychology about the nature, development and role of social interest as a community feeling and a foundation for cooperation between people. Social interest requires active communication, interest directed towards the other people in the surrounding environment and understanding of these people. As a child's basic needs for food, water, warmth and security are satisfied at the social institution, he does not find it necessary to develop richer, more meaningful speech. At the social institution, he does not use or very slowly learns how to use speech as a means of cooperation and connection. Evidence in support of this thesis can be found in the fact that children in social institutions exhibit relatively well-developed passive speech, while their active speech is much more lacking.

### Conclusion

The results of this study confirm A. Adler's idea that the ontogenetic development of special needs children is distinct for every individual. The psychomotor development of the children included in the study is atypical and characterized by deviations from the norm in regard to all evaluation criteria. However, the delay is most critical in terms of speech development, which is regarded as a form of expression of the child's social interest. The main underlying reasons for this are the children's special needs, the deprivation of maternal care and the limited linguistic environment.

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## EDUCATION CLUSTER “COLLEGE- INSTITUTION OF HIGHER EDUCATION” AS A FACTOR IN ENSURING QUALITY CONTINUING PEDAGOGICAL PROFESSIONAL EDUCATION IN THE UDMURT REPUBLIC

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The article is devoted to the problem of improving the quality of continuous pedagogical training. The publication discusses the impact of the educational “college – institution of higher education cluster” to ensure the quality of continuous pedagogical training. The need to develop a concept associated with the Office of social partnership in the education cluster, “college- institution of higher education”. The concept of educational “college – institution of higher education” cluster allows significantly increase the levels of general cultural and professional competence of bachelors and masters.

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**Keywords:** educational concept cluster “college – institution of higher education”, a mechanism for you to implement

Objectives of professional activity of graduates of colleges and universities are deterministic changes in socio-cultural and economic situation in the country. The main focus is to improve the socio-economic potential of the country through the preparation of highly qualified specialists. From graduates of educational institutions require ownership of universal characteristics: mobility in self-education; the perceived need for further training in continuing education; mastering general and professional competencies; skills to join professional contacts with colleagues and social partners; build professional growth based on constant updating of knowledge.

Empirical evidence suggests that graduates of colleges and universities do not acquire enough general and professional competences as a means to meet the challenges of professional activity. Professorial-teaching staff of the educational institutions recognized the need to upgrade the quality of education, offers a different concept and technology of continuous pedagogical education methodical means. However, the problem of providing quality continuing professional education must be addressed at the level of management and control mechanisms.

Approaches to the training of competitive specialist in theory of management developed by the authors: R.S. Nagovitsyn, I.V. Vladykina, P.B. Volkov, A.V. Tutolmin, E.I. Sokol'nikova [5], etc. researchers. Authors using methodological tools justified ways of improving the quality of education students, but is not considered a solution to the problem at the level of management education. In the works are not reflected the problem of improving the quality of continuous pedagogical vocational education under the education cluster,

preparation of highly qualified specialists examined through the prism of the improvement of the management process.

The analysis allowed us to formulate a research problem, which lies in the need to identify the nature of influences educational cluster “college – institution of higher education cluster” on the quality of continuous pedagogical vocational education on the basis of this definition and management mechanism of the education cluster. As such a mechanism could make the concept and technology realization of continuing professional education “college – institution of higher education cluster” in the Udmurt Republic.

Socio-economic importance of the problem and its not and geophysical data in the context of interdisciplinary studies identified the topic study: educational cluster “college – institution of higher education cluster”, as a factor in ensuring quality continuing professional education in the Udmurt Republic.

**Objective:** to introduce the concept of the education cluster “college – institution of higher education cluster” as a factor in ensuring quality continuing professional education in the Udmurt Republic, determine a mechanism for the implementation of this concept.

### Materials and methods of research

#### Objectives of research:

- submit testimonial concepts’ educational cluster “college – institution of higher education cluster” and quality continuing professional education”;
- substantiate the relationship quality continuing professional education and form: education cluster “college – institution of higher education cluster” and management of the relationship;
- develop the concept of the education cluster “college – institution of higher education cluster” as a factor in ensuring the quality of continuous pedagogical vocational education in the Udmurt Republic;

– implement the practical implementation of the concept of educational cluster “college – institution of higher education cluster” as a factor in ensuring the quality of continuous pedagogical vocational education in Udmurt Republic and to submit the results of its testing.

**Research methods:** theoretical analysis; content analysis of research works; diagnostic techniques, including synthesis of education value relations professional activities at Bachelors in conditions of education in college and University; analysis of the creative activity of students; prognostic methods; methods of mathematical statistics: analysis group, the analysis of statistical data, etc.

Methods used allowed capture qualitative and quantitative changes in the process of quality assurance of continuing professional education in the education cluster “college – institution of higher education cluster”.

**Research database:** Glazov state pedagogical institute, budget professional educational institution – college of information and communication technology social Glazov, budget professional educational institution of the Udmurt Republic “Yarsky polytechnic”. The study covered 1800 students, 200 high school teachers and professors. In the comparative analysis used materials association of universities in the Ural Federal University, Federal University of Kazan.

## Results of research and their discussion

**1. The concept of the education cluster “college – institution of higher education cluster”.** Form of educational institution-a result of harmonizing the positions of the social partners (colleges, universities, potential employers) on the goals, objectives, contents, organization and quality assurance of continuous pedagogical training.

**2. The notion of “quality continuing professional education”.**

Continuous pedagogical quality of vocational education on the objectives, content, organization and results satisfies:

- needs mobility students self-directed learning, including distance education; who need training in continuing education; who can join the professional contacts with colleagues and social partners to build a professional career based on constant updating of knowledge;
- requests to a professional society with mobility, competence, professional knowledge, skills and high professionalism, creativity, creative qualities, responsibility;
- state requirements to a specialist with modern educational technologies, general and professional competences.

**3. Relationship of quality of continuous pedagogical vocational education and form: the education cluster “college – institution of higher education cluster”.**

An important indicator of the quality of continuous pedagogical vocational education serves the overall competence of the students in their ability to deal with occupational tasks. Own moral standards and the foundations of

ethical behaviour (OK-3); speaking and writing skills; surf the Internet, use the methods and means of receipt, storage, processing information (OK-7); a high level of physical fitness to ensure full social and professional activities (OK-10) and professional tasks (using knowledge of different theories of learning, education and development, basic education programs for students in the pre-school, primary school and adolescents ages (OPIK- 4); organize various activities: gaming, learning, meaningful, productive and cultural activities establish a hobby (OPIK-5); responsibly and efficiently to perform professional tasks, while respecting the principles of professional ethics (OPIK-8); responsibly and efficiently to perform professional tasks, while respecting the principles of professional ethics (OPK-8); using verbal, visual, hands-on learning techniques using verbal, visual, hands-on learning techniques.

**4. Relationship quality management mechanism of continuous pedagogical vocational education and form: the education cluster “college – institution of higher education cluster”.**

Implementation mechanism of continuous pedagogical vocational education “college-institution of higher education cluster” in the Udmurt Republic aimed at the efficient allocation of resources (human, material, technical, financial) within the educational cluster that will tackle urgent problems purposefully.

Successfully linking the quality of continuous pedagogical vocational education and form: the education cluster “college – institution of higher education cluster” способствуют:

- preparation of professorial educational cluster to work together to ensure quality continuing professional education by improving knowledge and skills in the field of information and telecommunications technologies; participation in online communities pedagogical professionals professional education; increase quoting index authors ‘ works research;
- the improvement of educational quality assurance of continuing professional education;
- the use of administrative resources in management, accompanied by the process of the implementation of the concept (forecasting, monitoring, evaluation, discussion of results; providing educational resources).

**5. The concept of educational cluster “college – institution of higher education cluster” as a factor in ensuring the quality of continuous pedagogical vocational education in the Udmurt Republic** has the following form: the request by the Ministry of education of the Republic of Udmurtia. Determination of the results of the competition of

educational institutions for the development and implementation of the project. Search the designer a theoretical framework for the Union. Integration of educational institutions: “college – institution of higher education cluster”. Upgrading newly-minted educational systems (conversion to a single Inbox requirements into educational clusters, documents). The establishment, on the basis of innovative technologies: the creation of conditions for scientific and pedagogical practice in the educational cluster. Broadcast of educational services by educational cluster. Integration into the education cluster, for example, educational institutions of secondary vocational education system, education cluster. Review by external experts. Adjustment is a new revolution in the development of the education cluster at a high qualitative level.

Concept and realization technology of continuous pedagogical education “college – institution of higher education cluster” in the Udmurt Republic is ensured by the eight interrelated blocks: “target”, “theoretical”, “informative”, “software”, “software”, “personnel organizational management”, “implements”, “efficient”.

#### **6. The concept of educational cluster “college – institution of higher education cluster” as a factor in ensuring quality continuing professional education in the Udmurt Republic**

The mechanism of implementation of the concept of educational College-University cluster as a factor in ensuring the quality of continuing teacher education “college – institution of higher education cluster” in the Udmurt Republic aimed at the efficient allocation of resources (human, material, technical, financial) within the educational cluster that will tackle urgent problems purposefully.

7. Performance indicators from the introduction of the concept of cluster “college-educational institution of higher education cluster”, as a factor in ensuring quality continuing professional education in the Udmurt Republic

The main performance indicators should include:

– agreement between the social partners within the education cluster on the development of continuing professional education on the areas of training of bachelors and masters, the adoption and implementation of managerial decision-making, the development and implementation of a complex of measures on improvement of vocational training; the presence

of developing educational cluster links “college – institution of higher education cluster” in the field of continuing vocational training in the Udmurt Republic in the areas of training of bachelors and masters;

– positive dynamics of changes in knowledge, skills, general cultural skills and professional competence of bachelors and masters with the release of the education cluster “college – institution of higher education cluster”;

– implementation feedback educational cluster “college – institution of higher education cluster” with alumni and employers in the Udmurt Republic.

#### **Conclusions**

1. The characteristic of the concepts of “educational cluster”, “college – institution of higher education cluster” and quality continuing professional education”.

2. Justified relationship quality continuing professional education and form: education cluster “college – institution of higher education cluster” and management of this relationship.

3. The concept of the education cluster “college – institution of higher education cluster” as a factor in ensuring quality continuing professional education in the Udmurt Republic

4. Carried out the practical implementation of the concept of educational cluster “college – institution of higher education cluster” as a factor in ensuring quality continuing professional education in Udmurt Republic and presents the results of its testing.

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## SEMANTICS OF THE BASS REGISTER IN EUROPEAN MUSIC

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There are the semantic approach toward registers, specifically the low register of the human voice and musical instruments in the article. The low register sound accumulated a large semantic potential. It performs aesthetic roles (the accompaniment foundation, expressively important component of the musical fabric, the creation of an artistic symbol), decides the kinds of musical artistic problems (portray the owner of the low register, a dynamic condition of activity). The low register can embody the dichotomies: the Beautiful and the Ugly, the Sublime and the Malign, the Tragic and the Comic.

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**Keywords:** the low register of the human voice and musical instruments, the semantic, the Beautiful, the Ugly, the Sublime, the Malign, the Tragic, the Comic

For a long time, European science has studied musical resources in the aspect of their semantics, i. e. their ability to convey meaning. Discussions on the sense-bearing potential of ancient musical modes date back to Aristotle and Plato. During the baroque period, the meter, beat, and tonality semantics were actively developed within the framework of the theory of affects. The semantic approach toward registers, specifically the low register of the human voice and musical instruments, can be rather valuable for music.

The low register is represented by a considerably wide range of sources: vocal (a male bass or a female contralto) or instrumental (a bass-clarinet or a double bass clarinet, a bass saxophone in B and a double bass saxophone in Es, a contra bassoon, a bass saxhorn, a bass or a double bass trombone, a tuba, a double bass or a sub double bass tuba, a helicon, a double bass, an acoustic bass guitar, an electric bass guitar, a large or a bass drum, a low pitched church or orchestra bell, kettle-drums, a tam-tam). Folk instruments also complement the palette of low-pitch sounds: a karnay, an Uzbek copper instrument; a Russian bass or double bass balalaika, and a bass or double bass domra; a bass mandolin; a Mexican guitarrón (a large acoustic bass guitar); a bugay drum (berbenitsa) in its Austrian and Hungarian variants; and others. The low registers of acoustic instruments with a wide audio frequency range (an organ, a piano, a bayan (Russian button accordion), etc.) and electronic instruments (OndesMartenot, a theremin, a synthesizer) complete the acoustic picture.

The low register imparts with such qualities as the depth of overtones, density, substantiality, rigor, gravity, humming, certain hoarseness, an elusive clearness of the high pitch to the sound, often amplifying volume or even adding harshness, or, on the contrary – dimness and low level of volume (e.g. in the case of double bass). These qualities are due to the large size and mass of the sound source, the acoustic properties of the

sound (oscillation quality and amplitude, longer acoustic attenuation period), and difficulties of phonation.

The low register sound accumulated a large *semantic potential*. Conceptual impulses of music elements (including the register) are more prone to deciphering as associated with the **Human**. Since ancient times, low-frequency sounds have been attributed to a human who could generate it – a middle-aged man with a solid social status. It is not coincidence that many bass opera parts are those of rulers (King Mark in *Tristan and Isolde* by Richard Wagner; Tsar Ivan the Terrible in the opera *A Lady from Pskov*, Tsar Saltan from the opera *A Fairy-Tale about Tsar Saltan*, Tsar Dodon from the opera *The Little Golden Cockerel* by Nikolai Rimski-Korsakov; Czech king Vladislav in the opera *Dalibor* by Bedřich Smetana) and meaningful or celebrated characters (Ivan Susanin in the eponymous opera by Mikhail Glinka, *Il Commendatore* in *Don Giovanni* by Wolfgang Mozart).

Serious lyrical and dramatic monologues in chamber vocal music are usually recited by the bass voice. It can convey such human traits as sensuality (the part of Polovets khan's daughter Konchakovna – in contralto), wisdom of the middle age (Basilio, the teacher of music in *The Barber of Seville* by G. Rossini; the Old man in *Aleko* by S. Rachmaninoff; prince Gremin in *Eugene Onegin* by P. Tchaikovsky).

In all these cases, a person is characterized by means of its *speech*. Such deep sincere sharing quite often bears the meaning of author's monologues, uttered on behalf of the composer. They are also modelled in instrumental music by recitatives of low-pitch string instruments – cellos and double basses (in symphonies by L. Beethoven).

Bass register is also used in instrumental music to indicate that the character *is walking*. Steady and measured low register beats call for such association (example № 1: Chopin. Nocturne

C-Minor). Unsteady beats usually serve the purpose of conveying the specifics, how the person walks specifically (slow, heavy, difficult steps – a funeral procession in *The Musical Moment h-moll* op. 16 № 3 for piano by Sergey Rachmaninoff – example № 2). Low-pitch string instruments sound solidly in various tempo-gravitational models like a steady easy stride, plodding, etc.

Conceptual impulses of the low-pitch register also immerse the listener into **the World**, the human environment. The surrounding space is sonically materialized through such vibrations that stay beyond the acoustic abilities of human singing and speech. For example, they are associated with the imagined existence – the cosmic space (in the limitlessly long reverberating beginning of the symphonic the Planets suite by Gustav Holst). The world enters the musical opus with the striking of the clock heard in the lifelessly automated repetition of the low piano sound in the Variations on StilleNacht theme by Alfred Schnittke for violin and piano. This may also include associations with the real life, evoked by the imitation of the low-pitched church bell; they are frequent in the works of Sergey Rachmaninoff (for example, at the beginning of the Second concerto for piano with orchestra – example № 4); and found in Modest Mussorgsky's oeuvres – his orchestral Intro to the opera Khovanshchina, for instance.

Beyond the Man's limits, there is also the field of abstract categories. Among them, *the movement* as a mode of existence stands out. The absolutized energy of the pure abstract movement reigns in jazz improvisations, the double bass being well known to carry and conduct the motion energy.

Finally, along with the Man and the World another scope of senses – **the Music** itself – appears. It includes the sphere of musical elements, composers' and performers' ways for using these elements, the fund of musical genres, styles, techniques. The sphere of Music is constantly actualized as the traditional solidity of the low register. Most frequently, the Music is openly manifested as the demonstration of the performer's mastery. Here, the reproduction of the archetypical model of *singing* on an instrument inappropriate for this as the embodiment of the lyric can be pointed out. This model is used in Ludwig Beethoven's theme of joy (example № 5), Paul Erhard's transcription of Sergey Rachmaninoff's Vocalise, where the high-pitch human vocal is substituted with the double bass cantilena.

The other side of Music is revealed in the demonstration of *virtuosity* on a heavy "awkward" massive instrument – the command of the technique as the indicator of the performer's

mastery. It is easy to notice that "purely" (exclusively) musical assignments are quite harmoniously related to "non-musical" senses: the low-register cantilena is easily combined with the task of embodying the human principle, while the virtuosity happens to be the reverse side of the motion energy. In other words, various conceptual fields – the Man, the World, the Music – naturally merge in the same musical theme.

Let's proceed to *aesthetic roles* assigned to the low register.

*The accompaniment foundation* must be the most natural and simple aesthetic role of the low register. In this case, the low register focuses on a modest, inexplicit, impersonalized sound, serving as the basis for the homophone-harmonious texture and harmony. The low register as the basis of an ensemble's sound or orchestral polyphony – this is the role played by the ancient viola da gamba, also regularly performed by the double bass.

A more aesthetically interesting use of the low register can transform low-frequency sound into an *expressively important* component of the musical fabric. This is the case of the low vocals leading the Basso ostinato line. In Choir № 16 Crucifixus from the *Mess h-moll* by Johan Sebastian Bach, the low-frequency layer of the texture is not only the foundation of harmonic verticals. Multiple repetitions of the descending melodic line, defining the cadential closure, imparts the semantics of decay, withering, and perishing (example № 6). Not only the full lower register but also its separate phrasings can make a great aesthetic impression (example № 7 – Beethoven. Symphony № 5, part 3).

Among aesthetic roles of the low-register sounding, such an important one as the *creation of an artistic symbol* should be pointed out. Proclamations of doom are the most convincing in the low register. Persistent hits or rigid rhythm formulae with the beat being split into shorter values in the double bass parts are quite common for the Fate themes. Such signs are found in the final of the overture to the Carmen opera by George Bizet (example № 8), in the musical characteristics of Il Commendatore Statue in Don Giovanni by Wolfgang Mozart and The Stone Guest by Alexander Dargomyzhsky, and the leitmotif of Fate in The Ring of the Nibelung by Richard Wagner (example № 9). The similar themes are used to embody the inexorable sacred principle – this the trait of the oracles in Idomeneo by Wolfgang Mozart, Norma by Vincenzo Bellini, Aida by Giuseppe Verdi, and Dosifey – the leader of Raskolniki (the Free Churchmen) – in Khovanshchina by Modest Mussorgsky.

The most significant question arising in the process of studying the semantics of the low register must be the one on the kinds of musical *artistic problems* this instrument solves. Let's outline their most widespread figurative and artistic types in the musical art.

Let's start with an artistic situation, where we need to *portray* the owner of the low register. The artistic self-sufficiency of the low register is observed in multiple concertos for double bass with the orchestra (Paganini of the Double Bass by Giovanni Bottesini, Franz Joseph Ceper, Sergey Kusevitsky, Frantisek Gregora, Johannes Matthias Sperger, Domenico Dragonetti, and other authors) as well as comparatively less frequent double bass solos. Here the sound of the low-pitch string instrument is present extensively and profoundly, allowing the source of the sound to speak for itself. Leaping ahead, let me say that the portrayal of a massive and low sounding instrument became a productive creative idea for a wholesome musical and theatrical creative work – the Double Bass mono-opera by Grigory Korchmar, which I will cover a bit later. Moreover, it received its logical continuation in another kind of creativity – literature, namely Anton Chekhov's Romance with a Double Bass short story, Patrick Susskind's A Double Bass, Dmitry Yemets' Tanya Grotter and a Magical Double Bass. Let me add that the low register also convincingly portrays a specific, individualized *fantastic image*, like the Head in Ruslan and Lyudmila, the part of which is sung by a low male vocals choir with an octave span. This role is also well carried out by the solos of rare – extraordinary – low sounding instruments (bass clarinet, contrabassoon, and others).

Along with the static portrayal, the low register can also embody the opposite thing – a dynamic condition of *activity*. At the beginning of the final of Ludwig Beethoven's 9<sup>th</sup> symphony, vigorous replicas of cellos and double basses are included into the dialogues with other members of the orchestra (example № 10).

The low register can embody and encompass the concealed, deeply hidden meanings. Discovering these implications and comprehending the goals assigned is possible by means of the typology of aesthetic categories constituting the dichotomies. Let's look at them.

*The Beautiful and the Ugly.* The low register is used in both mentioned polarities. In music, we can find the idealization of the low register and its owner. This happens, for instance, during the demonstration of the double bass virtuosity in the transcription of Flight of the Bumble Bee by Nikolai Rimski-Korsakov. The high mastery of the performance and the

irrepressible creativity of the bass musician delight the listener of the jazz improvisation. In some genres of the rock music (heavy metal), the antipode – the embodiment of the ugly, gross, and even unaesthetic – can be played by the bass sound reduced to the level of noise.

*The Sublime and the Malign.* It might seem that low sounding is brutal and stands for the Malign. Such correlation really exists (e.g. in the beginning of the sonata for accordion De Profundis by S. Gubaidulina with low vibrations coming as if from the underworld), the part of Mephistopheles the Fallen Angel in Faust by Charles Gounod. The low register, however, also serves the opposite purpose – to represent the Sublime. Here, we are reminded of the traditions of the God-worshipping liturgical singing of the Gregorian Choral. The same is true for the Old-Russian liturgical singing: the sound of the male choir is acoustically perfect and rich in overtones not owing to the profoundly-sounding low vocals, but also to the lowest voice – *basso profundo* (those that possess the voice that low are called oktavists since they can sing an octave below other basses).

*The Tragic and the Comic.* Another dichotomy is well-represented in music. The tragic depth and significance mark the monologues of such opera characters as Ivan Susanin and Boris Godunov. The comic effect is achieved by overcoming the established tradition of demonstrating the worth and the meaningfulness of the pieces performed by the bass-register human voice. The hurry-scurry speech of the bass-register performers in Italian operas elicits a smile. The same reaction is expected from listening audience of the characters of the comic opera parts, such as Leporello in Don Giovanni by Wolfgang Mozart, doctor Bartolo in the Barber of Seville by Gioachino Rossini, Tsar Dodon and military commander Polkan in The Little Golden Cockerel by Nikolai Rimski-Korsakov, Farlaf in Ruslan and Lyudmila by Mikhail Glinka. The use of musical instruments beyond the limits of creative clichés sounds equally amusing. Take the playful and clumsy waltz melody of the double bass with the overlaid piano accompaniment in play № 5 “The Elephant” from “The Carnival of the Animals” by Camille Saint-Saens (example № 11) for example.

So, we have highlighted the great artistic potential of the low register, including the sound of the double bass. However, different musicians would use it differently. Let's consider how the double bass is interpreted by one of the most outstanding composers of Saint-Petersburg, our contemporary Grigory Korchmar in his monodrama the Double Bass.

About the composer.

## SEMANTIC FOUNDATIONS OF TRANSPOSITION OF LANGUAGE UNITS FROM ADVERBS INTO PARENTHETIC-MODAL WORDS AND EXPRESSIONS

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The article examines the semantic preconditions necessary for the transposition of linguistic units from the class of adverbs into the interstitial semantic and syntactic category of parenthetical-modal words and expressions. It was revealed that in Russian language adverbial word forms belonging to different semantic groups of the self-characterizing and adverbial modifier-characterizing adverbs are exposed to transposition which allows the subject of the modus to evaluate the information transmitted in the statement from different angles. Attention is drawn to the fact that this type of modalates characterize the reported information in terms of the logical evaluation of the situation (vice versa, additionally, conjointly, etc.), categorical and problematical reliability of the information and its connection with the source (for sure, likely, sooner, as I think/believe/say, etc.); expressive meaning (really, (to feel) pity, disturbingly, etc.); linguistic form of thought expression (generally, shortly, simply и т. п.); degree of the situation's commonness, its relationship to time (sometimes, frequently, rarely, usually, etc.).

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**Keywords:** Russian language, grammar, transposition, part of speech, adverb, modal word, semantic foundations

Studying the potential transposition of linguistic units that are different parts of speech is one of the most important tasks of transposition grammar of Russian language (see e.g. [1, 3–4; 6–13]. In this context, the process and result of the modalation of adverbs and short adjectives, including the ones that are used in an impersonal-predicative position, is of particular interest. As it was rightly pointed out by V.V. Babaytseva, "typical speech facts ("extreme cases", in the words of L. Shcherba) easily fit into the columns ("cells") of different classifications, and as a rule, do not cause problems. However, in a living language and speech facts that do not have a complete set of distinctive features of any particular grammatical category dominate. These cases are responsible for the existence of so-called "difficult questions of grammar" [1, p. 3–4].

Significant formation of syncretic word forms is generated by the mechanism of modalation of words and word forms from the class of adverbs into the interstitial class of parenthetical-modal units. Structure of modalates such as *for sure*, *generally* appears to have a complex grammatical interlacing of the features and functions of both adverbs and modal words, and when transposition is combined with the processes of particulation and conjunctionalization – the features of conjunctions and particles. Manifestations of interaction of category features in the syncretics' structure are quite diverse (see also [1–4; 14; 16–20]).

### Results of research and their discussion

Studying the mechanism of the transposition of language units from adverbs into the

interstitial class of parenthetical-modal units shows that certain semantic foundations are needed for the modalation of adverbial word forms, i. e. specific features of their structure and semantics which under the favorable syntactic conditions are able to change the traditional proportion of form and content thus providing the ability to express speaker's thought more precisely and in a saving manner. "Old" form in the context of the transposition is, in a way, adopting to express new meanings and semantic nuances (see also [1, p. 188–189]).

Semantic features of adverbs facilitate or hinder their categorical rebirth into modal words. It should be mentioned that, when determining semantic base of modalation adverbs, we abstract from those foundations which are relevant for the implementation of "parallel" transposition processes that involve the same adverbial word forms. For example, compare: (1) **"pure" type of modalation of adverbs** in cases such as *for sure* (1a) (modalate with a meaning of categorical authenticity); *my way (of thinking)* (1b) (modalate with a meaning of information source); *rarely* (1c) (modalate with a meaning of situation commonness degree); *(to feel) pity* (1d) (modalate with a meaning of emotional evaluation of utterance) and (2) **"combined" types of modalation of adverbs** that can be observed in the following combinations:

a) **modalation + particulation** (functional contingency with modal, affirmative particles in undivided sentences [*absolutely, surely, naturally*] (2a);

b) **modalation+conjunctionalization** [*then, later* (functional contingency with structural



words and conjunctions that perform connective function in a text) (2b) (see also the types of combination of transpositional processes in interjection of adverbs [8, p. 278–379, etc.]):

(1) (a) *It's better to act **for sure** → Don't hurry, there is no one there already, **for sure**;*

(b) *Let's do it **my way** now → In **my way** of thinking, this is all in vein;*

(c) *This can **rarely** be seen → He came to work on the stroke of 7 am, **rarely** – at the beginning of 8am;*

(d) *Everyone felt **pity** for that clumsy boy → **Pity**, but no one noticed his triumph.*

(2) (a) *He **surely** scored a success in this → “Do you agree with that decision?” – “**Surely**”.*

(b) *Then we'll discuss it detail → And **then**, we should keep in my mind that it's just the very first experience.*

What semantic foundations are needed to implement the modalization of adverbs, i. e. the transpositional process that can occur either in “pure” form or in combination with other types of interstitial part of speech transposition – particulation and conjunctionalization? Studies show that adverbial word forms that are present in two lexical-grammatical categories – self-characterizing and adverbial modifier-characterizing adverbs – are used in function of parenthetic-modal components (see semantic classification of adverbs in [5, p. 704–705]).

Among self-characterizing adverbs, words represented in several lexical-semantic groups are transposed into parenthetic-modal units.

**Firstly**, those are adverbial formations with semantics of way and manner of action that are transposed into modal words with meanings of: (3) logical evaluation of a situation (*vice versa, conjointly, additionally*); (4) categorical authenticity of information (*for sure*); (5) emotional evaluation of utterance (*really*); (6) linguistic forms of thought expression (*generally*); compare the following examples:

(3) *He always tried to do everything **vice versa** → Contrary to forecasts, the weather was not warmer, but **vice versa** – colder;*

(4) *No one knew the time of the train's arrival **for sure** → **For sure**, the equipment that was delivered is not enough;*

(5) *He **really** loved his work → **But really**, what kind of enemies are we?! We get along just fine;*

(6) *It's **generally** restricted to swim here → **Generally**, back then no one had a slightest clue about that.*

Among adverbs of manner there is a large group of words ending with suffixes -o, -e, the group consists mostly from descriptive adjectives;

they are transposed into parenthetic-modal words with meaning evaluation of utterance in terms of: (7) categorical and problematical authenticity (*absolutely, clearly, positively, resolutely, demonstrably, rightly, likely*); (8) emotional and expressive coloring (*disturbingly*); compare the following examples:

(7) *This word is **likely** to have resembling variants in many languages → It is **likely** that we'll part ways with our guide;*

(8) *That stranger acted quite **disturbingly** → **Disturbingly**, but no one even paid attention to that.*

Adverbial comparatives such as *shortly, precisely (speaking), accurately, simply* form a specific group of words that are subject to transposition into parenthetic-modal words and expressions with meaning of evaluation of linguistic form of thought expression, style and speech manner of a speaker (modus subject) (9). Such modalities are often synonymous to chunks of language with a verbal core – adverbial participles of infinitives; compare: *precisely ≈ precisely speaking; simply ≈ simply speaking*:

(9) *I can't quite comprehend you, speak **precisely** → I didn't know much about art, or, **precisely (speaking)**, didn't know anything at all about it;*

**Secondly**, among self-characterizing adverbs such singular adverbial word forms with quantitative semantics (degree) as *no way* are subject to modalization. They are used in parenthetic-modal position to evaluate information in terms of problematic authenticity (of supposition) (10):

(10) *There is still **no way** he can solve this → **No way**, this is Nikolay, but he should have left yesterday!*

**Thirdly**, self-characterizing adverbs with meanings of comparison or assimilation (11) are subject to transposition into parenthetic-modal words. They let speakers evaluate the degree of authenticity of utterances by quoting or referring to other people (*as you/we/I/ say/ believe, think*; and their colloquialisms *in their/ her language, etc.*)

(11) We have discussed several different options, but they decided to act **as we said** nonetheless → **As we said**, this is the best option.

Of course, not all adverbs of manner and degree are modalized. It is not likely to expect transposition of such adverbs with semantics of defined or undefined quantity as *twice, thrice, doubly, trebly, in twain, a lot, a few, not much/many, quite a few* into parenthetic-modal words. The same could be stated about adverbs with undertones of strengthening or weakening of characteristics such as *very, extremely*,

*exceedingly, devilishly, hardly, barely, almost, scarcely.* Russian language also lacks in modal words that originated from self-characterizing adverbs that express meanings of: comparison, assimilation (*bear-like, officer-like*); manner (such as *sideways, flatways, astride, lying down, when seated, when standing, at foot-pace, at a run, creepingly*).

Adverbial modifier-characterizing adverbs in some case are also transposed into modal words and expressions, for example: adverbs of time (*finally, ultimately, later, then, incidentally, sometimes, rarely, frequently*, comparatives (*sooner, (more) rarely, (more) frequently*, etc), semantic structure of which contains information about a sequence of events (*finally, ultimately, later, then*); adverbs of place (*opposite*); adverbs with meanings of place and time (*then*). Aforementioned adverbial word forms with temporal and diatopical meanings are transposed into parenthetic-modal words which are used by speakers to characterize the logical structure of an utterance (text), to express the chronological order of events, thoughts, etc. (*finally, ultimately, later*), to evaluate the authenticity of the information (*sooner*), commonness degree of a situation, its association with time (*sometimes, frequently, rarely, oftentimes, usually*; comparatives (*more) rarely, (more) frequently, etc.*). Compare the following examples:

(12) *Come sooner, please, I don't have much time* → *It's sooner to be true rather than not*;

(13) *The shop was just opposite to it* → *His arguments were opposite to his opponent's ones*;

(14) *Then we'll discuss the reasons of this happening* → *And then, we shouldn't forget about what was said at the Coordination Council's meeting*;

(15) *They usually met at some cultural events* → *Meetings took place on Sundays, usually – at half past 6*;

(16) *Rarely questions like that have been discussed lately* → *There was a lot of different mushrooms – birch boletes, red-cap boletes, sticky buns, and rarely – milk mushrooms and whitecaps*.

However, such adverbs of time and place as *nearby, far away, close by, beside, in front, indoors, by forest, by road, beneath, around, from afar, left, from above, internally; now, yesterday, tomorrow, today, instantly, daily, historically, at first, primarily, already, at day, at night, in the morning, in the evening, in summer, in autumn, in winter, in spring* are not used in parenthetic-modal position. Situations, where adverbial word forms of other semantic classes of adverbs are transposed, were not de-

tected. There is a complete lack of modalates that are relative to adverbial modifier-characterizing adverbs with meanings of:

a) simultaneity, collectivity (*together, conjointly, collectively, pair-wise, a deux, three, four* and etc.);

b) reason (*hotheadedly, blindly, from malice, etc.*) and c) purpose (*for spite, purposely, for fun* and etc.).

Parenthetic-modal words such as (*to feel*) *pity, strangely, naturally* are sporadic; they are relative to adjective and adverbial words forms, which includes their impersonal-predicative use (as a predicative); compare the following examples:

(17) *Pity, but we won't see again* (parenthetic-modal word);

(18) *His behavior spoke of pity* (short adjective);

(19) *His look provoked pity* (adverb);

(20) *It was a pity to say goodbye to someone you loved* (predicative);

### Conclusion

The foregoing gives us ground to assert that in Russian language adverbial word forms of different semantic groups of self-characterizing and adverbial modifier-characterizing adverbs are subject to transposition, which lets the modus subject to comprehensively evaluate the information contained in an utterance or a text. Modalates of the described type characterize the information in terms of logical evaluation of a situation, categorical and problematic authenticity of information, its connection with a source, emotional and expressive coloring; linguistic form of thought expression; commonness degree of a situation, its relation to time, etc.

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## Short Reports

**SOCIAL SAFETY OF THE PERSON AS A PSYCHOLOGICAL CATEGORY**

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Numerous studies and actual practice of the life and work show that for man to live and develop positively, conditions should be created under which he would feel comfortable and safe. One of the most urgent life's challenges and professional problems existing to date has been the problem of social safety of individuals and communities. The article highlights the social risk factors; the concept of social safety of the person as a psychological category. It is shown that social safety is determined by the environment and human behavior.

One of the most urgent life's challenges and professional problems existing to date has been the problem of social safety of individuals and communities. Under the conditions of radical social changes, all the basic elements of society functioning are changed, both at the state level and at the level of a particular person. Multi-aspect approach to security enables to consider security as a condition, which provides fundamental securitization of personality and makes it possible to consider personality security condition as a social and normative ideal [1, 3, 6, 7].

Social safety of the person as a social and psychological category has outer and inner determination and is influenced by psychological factors that are responsible for the achievement of its high level development.

There are external psychological factors of formation personality, such as functioning of the social institutions, the quality of the environment, the conditions provided by the society for the implementation of human capabilities.

The major premises for the emergence of social threats are the following:

- the increase in social tension caused by the economic and financial crisis, an increasing number of stressful situations and psychogenic disorders;
- influence of criminogenic factors;
- social unrooting of children and teenagers, the lack of psychological support provided by adults;
- the lack of legal culture and the necessary knowledge about psychology on the part of some authorities and the general public.
- the destruction or lack of effective methods of the creation of spiritual, moral, social and economical foundations needed for uniting the society;
- a decline in the general culture, discontinuity of social, cultural and national traditions;
- weakening of social control over unlawful conduct;
- a reduction in the opportunities for children's and teenagers' creative activities conforming to the relevant moral and ethical standards, which results in crime and anti-social behavior (from vandalism to delinquency and extremism);

– aggressiveness of infomedia, violence scenes on TV, in mass media, in the Internet.

Environmental psychology shows that the personality development occurs in a dialectical mutual transitions "subject – environment": environment influences on human feelings and behavior, and the same feelings and behavior affect the same environment [4, 5]. The surrounding social environment which tries to provide safety, can and must provide working out of adaptive forms of human behaviour in the society, provide possibilities and models of safe behaviour based on the experience of relations [2].

The ability to protect oneself from possible personal threats and capability of creating secure environment (secure relationship with environment) bear evidence of ideal level of cooperation of a human with social environment. The social environment of a human, which aims to guarantee safety, can and should promote the working out the adaptive behavioral forms of a human in the society, provide an opportunity and safe behavior pattern that is based on the experience of teaching of relations.

The relations between humans can be based on the mutual tolerance and collaboration, operation superiority, suppression, submission or care and support. For all these cases a personality is in different social environment with different degree of his/her social-psychological safety, and the process of personality's development will be different.

All the above mentioned that it's necessary to form and develop the personal social safety. We understand the development of person's social safety as active working aimed at creating safe environment and social institution with the purpose of protection from social risk factors and promoting the conscious attitude to personal safety of others, spiritual and moral qualities: skills of revealing, preventing, weakening and eliminating social dangers and threats that arise in the individual, group, social and cultural environment.

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